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THE EFFICACY OF MICRO-CLIMATE MODIFICATION UNDER INTERCROPPING SYSTEM

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ABSTRACT - The Efficacy of Micro-Climate Modification under Intercropping System
The objective of this field experiment was to study the effect of microclimate modification under intercropping system using two different row arrangements (2:2, 1:2) on the yield of corn (Reward variety) and two potato varieties (Frisia and Berca). Corn and potato yields were increased especially under 2:2 intercropping row arrangement. The increase of potato yield might be related to the reduction in air heat units (by 210 and 28), soil heat units (by 80 and 88), and light interception (by 350 and 344 $\mu mol.m^{-2}s^{-1}$) for "Fisia" and "Berca" varieties, respectively, as compared to their sole crops. Moreover, the values of soil moisture storage (SMS) and evapotranspiration (ET) for "Fisia" tended to decrease under intercropping as compared to sole cropping. While water use efficiency (WUE) of potato "Fisia" under intercropping was significantly higher than under sole cropping. On the other hand, the higher yield of corn under 2:2 intercropping row arrangement when compared to corn sole cropping was related to the higher values of the microclimatic factors. Additionally, planting two potato varieties (Berca and Frisia) in association with corn were efficient when compared to their sole crop, as judged by land equivalent ratio (LER) in all the combination tested.

Key words: microclimate, intercropping, potato, corn, LER

INTRODUCTION

Practicing intercropping system has proved to be more advantageous than sole cropping system. Over the past two decades, intercropping research studies in Jordan, as in many other countries, have led to the description of a number of distinct relationships between the intercropped species. The microenvironmental factors responsible for intercropping yield advantages were not fairly investigated, especially on potato / corn intercropping. However, the results of accumulated information indicated that the efficiency of light use could be an important factor for the yield advantages for both millet / grondnut combination (RADKE AND HAGSTORM, 1976), potato / faba bean (SHARAIHA AND HADDAD, 1986), Okra / peas (SHARAIHA AND HADIDI, 2007). KURUPPUARACHCHI (1990) indicated that the benefits of shading on intercropped potato yields were variable and this variability might be related to the degree of shading. BATUGAL ET AL. (1990) showed that intercropping potato with maize could be beneficial in providing partial shade to the potato and reduce both air and soil temperatures and thus favor tuber production. SHARAIHA AND KLUSON (1994) reported that both air and soil temperatures required for faba been nitrogen fixation were significantly higher when faba bean was planted with peas or with lettuce as compared with its sole crop. FURTHERMORE, JIEMING AND MIDMORE (1990), found that higher yields of corn intercropped with potato were due to higher amount of soil moisture storage caused by the decrease in demand of water after potato maturity. AL- QAHWAJI (1995) mentioned that evapotranspiration for potato and faba bean under intercropping was less than that of sole cropping, while water use efficiency was significantly higher under intercropping than sole cropping. Since the microenvironment under intercropping system depends on many factors such as climate, soil, crops combination and row arrangements, more work of this nature is needed to provide more information and better understanding

of these principles in order to improve intercropping system. Therefore, the objective of this field experiment was to study the effect of the following microclimatic factors: light interception, air and soil temperatures, evapotranspiration, or plant water consumptive use and water use efficiency on the yields of two potato varieties, and corn as they are grown under intercropping and sole cropping.

MATERIALS AND METHODS

An experiment was carried out in Rabba at the Faculty of Agriculture Research Station, University of Mu'tah. The station is located at altitude of 31.2°N, 35.5°E, with an elevation of 920 m above sea level, and 120 km South of Amman. The soil texture is clay loam; the climate is semi-arid with mean annual precipitation of 326mm and mean annual temperature of 16.2°C. Two Potato varieties - *Solanum tuberosum L.* - (Berca and Frisia), and one variety of corn *(Reward) Zea maiz* were planted under two selected intercropping arrangements, that was based on previous study (Sharaiha and Haddad, 1985), in addition to their sole cropping. A randomized complete block design with three replications was used. The treatments included: 1- pure stand of potato"Fisia"variety; 2- pure stand of potato "Berca" variety ; 3- 2:1 potato "Fisia"variety / corn intercropping row arrangement; 4- 2:1 potato "Berca variety / corn intercropping row arrangement; 5- 2:2 potato "Frisia" variety / corn intercropping row arrangement; 6- 2:2 potato "Berca" variety/corn intercropping row arrangement. Each treatment plot consisted of six rows 75cm apart and 4 meters long. Spacing between plants within row was 35cm for potato and 15 cm for corn and bean. Compost poultry manure was applied one week before planting at the rate of 15Mt.ha^{1}. Weeds were kept under control manually. Surface laterals of 16mm diameter were installed on every planting row to deliver water to plants. In line, drippers with 40cm spacing and 4 liters per hour per dripper discharge rate were used for irrigation. The amount of water added was recorded by water flow meter. Soil moisture measurements were taken at 7.5, 22.5, 45 and 75cm soil depth. In addition, gravimetric method was used to support neutron probe readings for the two first layers. Two access tubes (90cm long) of two inches diameter were installed within the row between two adjacent potato and bean plants under intercropping treatments, while one access tube was installed for each sole crop. Calibration for different soil layers was correlated with soil moisture counts of neutron probe with gravimetric soil moisture samples. Linear regression equation for calibration of neutron probe for the third layer was Pv% = 38.30 CR- 22.08 and that for the fourth layer was Pv% = 29.88 CR – 15.23, where Pv% is a volumetric moisture content and CR (count ratio) is a neutron probe reading in the field. Crop evapotranspiration (ET) and soil moisture storage (SMS) were calculated by using the following equations: - ET= R + I + DSi – DP. Where R : is the amount of rainfall and it was = 0, I : is the amount of irrigation, Dsi : is the initial soil moisture content, and DP : is deep percolation and it was = 0. SMS = $\sum$ [increase in soil moisture (+Δ s)]. Where Δs is the difference between two neutron probe readings for the soil moisture storage taken after irrigation by 16 hours and before each irrigation. While water use efficiency (WUE) was calculated by dividing yield over ET. Daily light and temperature (air and soil) measurements (taken between 11AM and 1PM) started 24 days after emergence using porometer and thermometer, respectively. However, temperatures were recorded as heat unit, using the 50-86F method as described by BATTIKHI AND GHAWI, (1987). The heat unit method should indicate which of the treatments provided best temperature for plant growth. Light measurement was taken at the lower, middle and the upper part of the stem (averages were calculated). Harvesting date was on July 10 -11 for potato and corn, while for bean (green pod) started on May 26

– July 9. Yields of the three crops were obtained from the middle three meters of the central four rows, for 2: 2 row combination and from the middle of the central three rows, for 1: 2 or 2: 1 row combinations. The land equivalent ratio (LER) was calculated for the combined intercropped yields and for the intercrop yield of each crop, as described by WILLEY (1979), who expressed the intercrop yield on a relative basis to a sole crop yield (i.e. where LER = 1). Analysis of variance for the micro environmental values and yield data were determined. The Duncan's Multiple Range Test (DMRT) was then employed for means separation.

RESULTS AND DISCUTION

Effect of Air and Soil Heat Units on Yields of Two Potato Varieties under Intercropping with Corn and Sole Cropping.

Table 1, shows the comparison of air and soil heat unit for the two potato varieties "Fisia" and "Berca" grown under sole cropping and intercropping with corn. A reduction of air heat unit with significant differences was observed in the potato intercropping treatments as compared to potato sole cropping treatments. The recorded reduction in air heat unit was 210 and 227 for potato "Fisia" in the 2:2 and 1:2 intercropping row arrangement, respectively. While the recorded reduction in air heat unit was 28 and 224 under the same treatments, respectively. On the other hand, the recorded reduction in soil heat unit was 80 and 151 for potato "Fisia" while for potato "Berca" was 88 and 156 when they were grown with corn under 2:2 and 1:2 row arrangements, respectively. The reduction of both air and soil heat units under intercropped potato were due to the shading effect caused by the accompanied corn crop. However, the significantly higher yield of the two potato varieties were obtained under 2:2 intercropping row arrangement as compared to both potato varieties grown under sole cropping system (Table 1) where the minimum reduction of air and soil heat unit were recorded. Therefore, a certain amount of shading gave optimum air and soil heat units that affected significantly the yield of the two potato varieties. Similar results were obtained by Batugal et al (1990) who showed that the increase in potato yield under potato corn / corn intercropping resulted from the temperature – reducing treatments in comparison with potato sole crop. Moreover, when the two potato varieties were considered within each cropping system namely 2:2 and 1:2 and sole cropping, the air heat units of the intercropped potato "Berca" was significantly higher than that of the intercropped potato "Fisia", while under sole cropping, significant differences did not occur. On the other hand, differences in yield between the two intercropped potato varieties under the same cropping system were insignificant (Table 1). This could be explained by the fact that air and soil heat units requirements were within the range; even though air heat unit in the 2:2 and 1:2 intercropping row arrangements were significantly less than under sole cropping system.

Effect of Air and Soil Heat Units on Yields of Corn under Intercropping with Two Potato Varieties (Frisia and Berca) and Sole Cropping.

When corn was planted with the two potato varieties "Fisia" and "Berca" under 2:2 and 2:1 row arrangements the air and soil heat units were higher than corn sole crop (Table 2). This could attributed to wider spacing between rows as corn was planted in such row

arrangements, where the incident radiation could penetrate through the intercropped corn plants to soil surface. While corn planted as sole crops has a dense canopy and therefore less incident radiation passes through all the leaves along the corn stem. This might explain the higher air and soil heat units obtained under corn intercropping as compared to corn sole cropping. Three hypotheses can be drawn from table 2 when a comparison between the two cropping systems (intercropping and sole cropping). Three hypotheses can be drawn from table 2 regarding both air and soil heat units, in relation to corn yield, were made. The first, when air and soil heat units values were significantly higher under intercropped corn than under sole corn (such as in 2:2 corn potato "Fisia" intercropping row arrangement), the highest significant corn yield was obtained for 2:2 corn potato "Fisia" intercropping row arrangement as compared to the yields obtained in all other treatments (intercropping and sole cropping table 2). The second, when only the air heat unit values were significant higher under intercropped corn than under sole corn plants (such as in 2:2 corn /potato "Berca" and in 2:1 corn potato
"Fisia" intercropping row arrangements), significant higher yields of corn were obtained for the same treatments mentioned above, as compared to sole corn yield, but significant lower yields than 2:2 corn potato "Fisia" intercropping row arrangement. The third, when air and soil heat units values under intercropped corn plants were not significantly different as compared to the values of air and soil heat units under sole corn plants (such as in 2:1 corn /potato "Berca" intercropping), in this case, the corn yields under intercropping and sole cropping were not significantly different. Furthermore, when the two varieties of potato were considered (Fisia and Berca), corn gave significant higher yields with potato"Fisia" than with potato "Berca" (Table 2). This means that potato"Frisia" have had a beneficial effect on corn yield more than potato "Berca" when grown together, due to variety environment (including air and soil heat units) interaction. This fact had been indicated by SHARAIHA (1994), ABU SALEM (1993), CHANDEL ET AL 1987), SHARAIHA (1996).

Effect of Light Interception on Yields of Two Potato Varieties under Intercropping with Corn and Sole Cropping

When the two potato varieties (Fisia and Berca) were planted with corn under dry summer seasons, average light interception by potato was significantly lower than their sole crops (Table 1) due to the shading effect caused by the associated corn plants). A decrease in light interception of 350 and 450 $\mu mol.m^{-2}s^{-1}$ were obtained when potato "Fisia" was grown with corn under 2:2 and 1:2 row arrangements, respectively. While in the case of potato "Berca" the reduction in average light interception was 344 and 508 $\mu mol.m^{-2}s^{-1}$ under the same row arrangements, respectively. However, significant higher yields of the two potato varieties were obtained under 2:2 intercropping row arrangement as compared to their sole cropping (Table 1) where the minimum reduction of light interception were obtained (Table 1). it seems that certain amount of shade play an important role in increasing potato yield production. Similar results were obtained by Kuruppuarachchi (1990), and by Harris (1990). Moreover, average light interception by potato "Berca" was higher than by potato "Fisia" when they were grown under same cropping system (2:2 and 1:2 and sole), the highest significant differences between the two potato varieties were obtained under 2:2 intercropping row arrangement and sole cropping. This could be explained by the differences in their canopy development. However, differences in yield between the two potato varieties under the same cropping system were insignificant (Table 1).
This could be an indication that light interception for both potato varieties under these conditions were within range even if significant differences occurred.

Effect of Light Interception on Yields of Corn under Intercropping with Two Potato Varieties and Sole Croppping

Table 2, shows that corn intercropped with the two potato varieties "Fisia" and "Berca" intercepted more light as compared to corn sole crop. However, significant higher light interception was obtained when corn was planted with the two potato varieties under the 2:2 row arrangement; where it gave an increase in light interception of 62 $\mu mol.m^{-2}s^{-1}$ by corn planted with potato "Fisia", and 94 $\mu mol.m^{-2}s^{-1}$by corn planted with potato "Berca" over the light interception by corn sole crop. While under 2:1 row arrangement, corn plants obtained an increase of 40 and 42 $\mu mol.m^{-2}s^{-1}$ when planted with the two potato varieties "Fisia" and "Berca", respectively, over the value of light interception obtained by corn sole crop. On the other hand, intercropped corn yields were significantly higher than the yield of corn sole crop, with one exception and that when corn was planted with potato "Berca" variety under 2:1 row arrangement, where an insignificant increase of 44% over the yield of corn sole crop (Table 2). The efficient use of light by corn and consequently on its yield, was due to wider spacing between rows, as corn was planted with potato in 2:2 and 2:1 row arrangements. This fact was pointed out by SHARAIHA AND HADIDI (2007) in their work on okra peas intercropping and BATUGAL ET AL (1990) in their study on intercropping potato with maize. MOREOVER, TRENBATH (1976) indicated that a plant with a usually long shoot, such as corn in a dense sole crop would experience an especially unfavorable light regime and lead to a poor root/shoot ratio due to the scarce supply of photosynthate. Therefore, the relatively small root of corn under sole cropping could be less efficient in using resources (moisture and nutrients) as compared to the roots of intercropped corn, which might have better distribution and eventually better use of resources.

Effect of Intercropping Potato/Corn on Soil Moisture Storage (SMS) Evapotranspiration (ET) and Water Use Efficiency (WUE) VS Potato Yield

Intercropped potato with corn did not have any significant effect on SMS as compared to its sole crop (Table 3). However, the values of SMS were generally lower under intercropping than under sole cropping. This fact was not expected due to the lower values of both air and soil heat units (Table 1) and to lower values of ET obtained under intercropping as compared to sole cropping (Table 3). other factors such as water extraction of potato which might use 80% from its water requirement from soil depth of 20 -25cm (Sharaiha, unpublished data), while corn might have extracted water from the whole root zone, thus competition for water especially at the upper part of soil depth might exist, leading to a reduction in SMS under intercropped potato as compared to sole potato. These results agree with the findings of TRENBATH (1976) and contradict the findings of JEIMING AND MIDMORE (1988), obviously due to different experimental conditions, where they used plastic mulch in the first experiment and irrigation was not practiced in the second experiment. Moreover, the reduction in SMS did not affect the higher yields of potato obtained under intercropping (Table 3 and 1), as long as irrigation was applied. Furthermore, the ET values obtained for intercropped potato was generally lower than the values obtained by potato sole crop (Table 3). However, the lowest significant values of ET was obtained for intercropped potato was obtained under 1:2 potato/corn intercropping row arrangement as compared with potato sole croppping due to the effect of shading caused by corn plants. However, potato yield under this treatment was not significantly higher than potato yield under sole cropping. Similar results were obtained by AL-QAHWAJI (1995), in his work on potato faba bean intercropping. On the other hand, potato

yield was higher under intercropping than under sole cropping especially when potato was planted with corn in 2:2 row arrangement, where a significant difference was obtained under insignificant values of ET, this could be due to other factors that caused the higher yield production of potato, such as air and soil heat unit and light interception (Table 1), where they were higher under this treatment than the treatment of potato sole crop. RADKE AND HAGSTROM (1976) explained the higher yield production due to higher dry matter obtained by sheltered crops, where their transpiration to evaporation ratio is higher than unsheltered crops. Aside from the reduction of SMS and ET under potato/corn intercropping, WUE was improved significantly (Table 3). The higher significant values of WUE obtained by intercropped potato were due to higher yields of potato as compared to potato sole crop, since WUE was calculated by dividing yield over ET. The higher potato yields obtained under intercropping system, could be due to the interactions among different factors under 2:2 and 1:2 row arrangements

Effect of Intercropping Corn/Potato on Soil Moisture Storage (SMS) Evapotranspiration (ET) and Water Use Efficiency (WUE) VS Corn Yield

Table 4, shows that when corn was planted with potato, the values of SMS tended to be higher than the values obtained by corn grown as a sole crop. Similar results were obtained by OLASANTAN (1988) in his study on corn/watermelon intercropping, who suggested that watermelon protected the soil against insulation, helping water to infiltrate and minimize water losses by evaporation. However, corn water consumptive use (ET) was also increased when it was planted with potato as compared to corn sole cropping (Table 4), especially under 2:1 corn/ potato row arrangement where significant differences were obtained. The higher values of ET could be related to the higher values of air and soil heat unit, (Table 2) and SMS (Table 4) obtained under intercropped corn as compared to corn sole crop. These results contradicted the findings of AL-QAHWJI (1995), and agreed with the results obtained by JANA ET AL. (1995). Moreover, the values of WUE of intercropped corn were significantly higher than that of corn sole crop. The highest significant value of WUE for corn was obtained under 2:2 corn / potato intercropping row arrangement, where it gave an increase of 0.881 ton/ha/cm over the value of WUE obtained by corn sole crop. Therefore, the higher yield of intercropped corn as compared to the yield of corn sole crop could be related to the higher values of air heat unit, soil heat unit, light interception, SMS, ET and WUE (Tables 1 and 4) obtained under corn
Intercropping over corn sole cropping.

Efficiency of Intercropping

Land equivalent ratio (LER) is one of the methods used to evaluate the intercropping system, it is defined as the relative land area under sole cropping that is required to produce the yield achieved in the intercropping. When the values of LER are greater than one under intercropping, this result indicates greater efficiency or over yielding of land use compared to sole cropping. Table 5, shows that when corn and the two potato varieties (Fisia and Berca) were intercropped under 2:1 and 2:2 row arrangements, the LER values obtained were higher than one. It is also clear that the efficiency of intercropping was affected by the potato variety as well as by row arrangement. This is logical since each crop arrangement allowed for a special local microenvironment. Changing to a certain limit the competition for light, moisture and nutrients. Comparison of the relative LER values of corn intercropped with the two potato varieties (Fisia and Berca) under the two different row arrangement (Table 5), indicates that corn planted with potato "Frisia" was

more preferable than with potato "Berca". The highest relative LER was obtained when corn was planted with potato "Frisia" under 2:2 and 2:1 row arrangements, where corn gave 1.45 and 1.43, respectively. These values are 0.95 and 0.77 higher than the expected LER value obtained for corn sole crop in one half and two thirds of the land, where LER equal o.5 and o.66, respectively. Moreover, when corn was planted with potato "Berca" under the same row arrangements, the relative LER values obtained by corn were higher by 0.6 and 0.33, respectively as compared to corn sole crop planted in 0.5 and 3/3 of the land. The high efficiency of corn as it was planted with the two potato varieties found in this study agreed with the finding of WILLEY (1979), AL- QAHWAJI (1995), GLIESMAN, AND SHARAIHA AND HADIDI (2007) who explained this phenomenon from the complementary use of growth resources over time and space. Again, comparing the LER values of the two potato varieties (Fisia and Berca) intercropped with corn, it was observed that potato "Frisia" variety gave higher relative values of LER than potato "Berca" under the two intercropping row arrangements used (2:2 and 1:2), where potato "Frisia" gave a relative LER of 0.70 and 0.41, respectively. This could be attributed to the differences in yield between the two potato varieties grown under intercropping and sole cropping (Table 2-A). Moreover, the higher total LER of corn / potato intercropping was due to the higher contribution of corn, which might use the available resources better than corn planted under sole cropping.

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Table 1: Effect of Light Interception Air and Soil Heat Units on Yields of Two Potato Varieties under Intercropping with Corn and Sole Cropping.

Row arrangements	Light Interception $\mu mol.m^{-2}s^{-1}$	Average Air heat unit	Average Soil heat Unit	Yield Ton / ha
2 rows potato Fisia 2 rows corn	907 d	2014 c	1205 b	36.0 a
2 rows potato Berca 2 rows corn	1006 c	2203 b	1553 ab	34.1 a
1 rows potato Fisia 2 rows corn	807 e	1997 e	1134 b	31.4 ab
1 rows potato Berca 2 rows corn	842 de	2007 d	1185 ab	31.5 ab
Potato Frisia Sole crop	1257 b	2224 a	1285 a	25.7 b
Potato Berca Sole crop	1350 a	2231 a	1341 a	27.7 b

Values without common letters are significantly different using DMRT at 0.05 level

Air and soil heat units are analyzed separately – soil heat unit at 5cm depth.

Heat unit or daily growth is measured by using the 50-86°F

Table 2: Effect of Light Interception Air and Soil Heat Units on Yields of Corn under Intercropping with Two Potato Varieties (Frisia and Berca) and Sole Cropping.

Row arrangements	Light Interception $\mu mol.m^{-2}s^{-1}$	Average Air heat unit	Average Soil heat Unit	Yield Ton / ha
2 rows corn 2rows potato Frisa	1147 ab	2222 a	1671 a	3.33 a
2 rows corn 2rows potato Berca	1206 a	2220 a	1612 a	2.54 b
2 rows corn 1 row potato Frisa	1152 b	2216 a	1503 ab	2.47 b
2 rows corn 1 row potato Berca	1154 b	2198 b	1130 ab	1.66 c
Corn Sole crop	1112 c	2193 b	1019 b	1.15 c

Values without common letters are significantly different using DMRT at 0.05 level

Air and soil heat units are analyzed separately – soil heat unit at 5cm depth.

Heat unit or daily growth is measured by using the 50-86°F

Table 3: The effect of soil moisture storage (SMS) evapotranspiration (ET) and water use efficiency on the yields of two potato varieties under intercropping and sole cropping

Row arrangements	SMS mm	ET mm	WUE Ton/ha/cm
2 rows potato Fisia 2 rows corn	25.14 a	25.9 ab	1.314 a
1 row potato Frisia 2 rows corn	23.23 a	23.9 b	1.311 a
Potato Frisia Sole crop	27.6 a	28.5 a	0.903 a

Values without common letters are significantly different using DMRT at 0.05 level

Missing data for potato Berca was due to uncontrollable conditions

Table 4: The effect of soil moisture storage (SMS) evapotranspiration (ET) and water use efficiency on the yields corn under intercropping and sole cropping

Row arrangements	SMS mm	ET mm	WUE Ton/ha/cm
2 rows corn 2 rows potato Fisia	23.6 a	24.42 ab	1.37 a
2 rows corn 1 row potato Frisia	24.87 a	25.67 a	0.963 b
corn Sole crop	21.9 a	23.52 b	0.489 c

Values without common letters are significantly different using DMRT at 0.05 level

Missing data for potato Berca was due to uncontrollable conditions

Table 5: The relative yields, relative LER and total LER of the two potato varieties (Berca and Frisia) and bean grown under intercropping system

Row Arrangements	Relative yield Ton/ha		Relative LER		Total LER
	Potato	Corn	Potato	Corn	
2 rows potato Frisa 2 rows corn	18.0	1.66	0.70	1.45	2.15
2 rows potato Berca 2 rows corn	17.05	1.27	0.61	1.10	1.71
1 row potato Frisia 2 rows corn	10.46	1.65	0.41	1.43	1.84
1 rows potato Berca 2 rows corn	10.5	1.11	0.38	0.96	1.34

Each sole crop = one

POSSIBLE ADVANCES OF THE CLIMATIC CHANGE IN AGRICULTURAL PRODUCTION AND IN HUMAN NUTRITION

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About global climate change

The relationship between nature, economy and society came into the foreground in debates about sustainable development for nearly two decades they. Many people agree today, that the destruction of the natural environment may cause social and economic problems thus may turn into a political issue as well. The period of the global warming began according to the representatives of the science, the climate change came into the foreground, the average temperature of the surface of the Earth has already risen by nearly a degree. We got used to the fact of the climate change, on the other hand the debates are going on if global warming is merely a natural phenomenon (according to historical records there were times when such happened), or it is a consequence of human effects (human activity). It's possible, that both factors prevail collectively and they intensify each other mutually.

The phenomena demonstrating climate change

Extreme meteorological and environmental phenomena such as floods, internal waters, droughts, heat waves, wind-storms, early and late frosts, hails and mud avalanches call the attention for the climate change. They existed in the past and certainly they will also appear in the future causing considerable damage. It was observed that these extreme meteorological phenomena appeared more frequently with the global warming. It serves the clarification the changes and their reasons if we adjust to the environmental phenomena (adaption), both on the level of society and on the level of economy. Considering prevention and relieving the harms we may rightfully suppose that with reducing the quantity of green-house gases getting into the atmosphere because of human activities the situation can be stabilized.

The judgement of the climate change

The debates about the reason of the climate change are not over yet, but there is a definite opinion not to wait for the end of the debates; it is necessary to decide, to get ready and to act. (LÁNG I., 2008) Our Earth sends unambiguous alarm signals, this is why the emission of gases with a greenhouse effect causing the global warming should be reduced.
The academic world reckons with a continuous warming. The „Rio Declaration" issued in 1992 created the principle of a precaution, according to which in case of vague or serious situations it is not necessary to wait for full scientific certainty; it is necessary to look for solutions and to apply them.

Hungarian events and phenomena linked to climate change

The storms and hails caused severe damage in Hungary beside the local phenomena of recurrent floods entailing mud avalanches on the River Tisza and on smaller rivers and

brooks. The average temperature rose unambiguously between 1975 and 2006, the moisture decreased. At the same time heat-waves and drought years spoiled the population's living conditions and economic conditions. Especially the agriculture suffered because of these extreme meteorological phenomena, due to which – through the crop fall-out - food production and consumption decreased. The bush fires and forest fires as well as the increasing UV radiation new pests (e.g. insects) appeared in the Carpathian Basin. Environment change researchers reckon with 11 phenomena that will be more frequent in Hungary in the future.

Hungarian climate change

From among the domestic changes the best measurable are the temperature values: in the past 100 years the winters and springs differed from the yearly average less, while the summers got hotter and the autumns less warm. When examining the monthly average temperatures the temperatures of 11 months shows an increase, with December as an exception. The months of the summer half-year show a significant increase while we experience positive and negative trends equally at the others. Based on the climatic model forecasts we can count on an accelerated warming. The middle part of the country is getting warmer, while the South-West and it South-East areas less warm. The summer heat is growing as well as the number of the warm nights, which spoils the essential life conditions and the health of living beings significantly.

Changes linked to precipitation

The moisture (precipitation) is a much more unsettled parameter than temperature therefore it is more difficult to draw conclusions. In Hungary the decrease of the annual amounts of precipitation can be observed, but an increasingly bigger part of it falls down in the form of intensive rainfalls. The natural and economic utilisation of the moisture is deteriorated for two reasons: less moisture arrives and it drains away because of the intensive rainfall (less can leak into the soil so less can be stored). The agricultural damage is increased if the upper layer of the soil does not become saturated with water at the beginning of the vegetation period. Droughts and inundations have always been In Hungary, but while the country was rarely inhabited, meteorological phenomena occurring on the smaller areas remained unnoticed.

Proposals for the utilisation of plant production benefits

The plough-land and horticultural cultures already suffer because of the changes in the temperature and the moisture. On the plough-land the preference of drought-resistant species and kinds is expedient on the one hand through the traditional, natural cross-breeding work, on the other hand through the results of modern biotechnology (genetic technology) where the country's economic-political and environment protection interests make it possible. The European Union promotes the growing of durum wheat in Hungary, particularly with the aim to replace the eggs used to give a yellow colour in the production of the pasta.. In the field of horticultural production today we can already reckon on the growing and harvesting of plants, mainly from the Mediterranean zone, which were not provided until now. From among the woody plants we can mention the olive tree. In case of the ripening of the crop of the olive tree olive oil extraction is possible in the future. Because of its oleic acid combination olive oil has much better nutrition physiology

characteristics, than the present sunflower (and rape) oils. We can already find fig trees here and there in Hungary, which can give ripe fruit.

Possible changes in animal production concerning the forage

The climate change can be expected to affect the grasslands mostly, since observations in the past few decades found damages on this area in the pasture farming. The regional livestock concentration is not followed by the designation and cultivation of the grazing areas thus, expectedly the proportion of livestock kept on dry forage will increase. Regarding the corn-based and Soya-bean-based fodder the Soya bean may cause tension because Soya-bean is imported mainly from non-EU areas. The production in Hungary depends on irrigation mostly.

Changes caused by climate change in the population's nourishment

The Hungarian population have already made changes in their nourishment up to now, therefore the main principles of modern nourishment for instance the food and drink of the popular Mediterranean cuisine are presumably not unknown for them. Like the other member states of the European Union we also took over the Italian pastas (and pizzas) and the consumption of green salads at the beginning of dining. Due to the warming it would be wise to eat little but more times daily; the smaller consumer portions and packaging methods can contribute and help it. The wide choice of the Mediterranean fruits and their accessibility all year round for Hungarian people have already changed a lot in fruit (and not only seasonal fruit) consumption habits. The demand for mineral water may be growing in the coming years while in grape growing it is possible that vine-giving grape species with an increased alcohol content-usual on the Mediterranean areas come into the foreground In Hungary.

SUMMARY

1. In Hungary a long term increase of gradual warming, the decrease of the quantity of the moisture and the increase of extreme meteorological events and their intensity and damage can be expected.
2. It is necessary to prepare the economy and the population for a warmer and drier period according to the strategy of adaptation.
3. It is necessary to make conditions to provide a fast response for the prevention of the deleterious effects of extreme meteorological events coming forward unexpectedly on organizational and technical level.
4. From among the regional concerns of the expected changes primarily the eastern and northwest areas of Hungary dominate in getting warm, while it will be the least in the country's middle part, at the same time it is difficult to draw conclusions on the moisture amount in the region.
5. Although Hungary is situated on the border of the zones with opposite signs, we can count on a decrease in precipitation just like the Mediterranean areas.
6. As for the cultivation of native plants the drought-resistant kinds should be promoted while from among the Mediterranean species the ones adapted to the new conditions are to be planted.

7. Regarding animal production with the increase of the irrigated areas it possible to insure the needs of races demanding the green fodders.
8. In the Hungarian population's nourishment the so-called Mediterranean diet should be highlighted taking advantage of the conditions of the wide-range food trade provided by the European Union.

GAME MANAGEMENT IN HUNGARY - HOW CAN IT BE INFLUENCED BY CLIMATE CHANGE?

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According to the theories accepted by the scientific community, the recent changes in climate can be at least partly attributed to the activities of mankind. As different parts of Earth are warmed separately, the changes in other meteorological parameters also show variations (LÁNG ET AL., 2007).

Changes in climate will force individual species of plants and animals to adjust, if they can, as they have in the past. Migrations would be much more difficult because they would entail migration across highways, agricultural zones, industrial parks, and 21st century cities. An even further complication arises with the imposition of the direct effects of changes in CO_2, which can change primary productivity as well as alter the competitive relations among photosynthetic organisms (ROOT AND SCHNEIDER, 2002). During this century, projected changes in temperature and precipitation patterns are expected to intensify the impacts on species and ecosystems in many areas. Floods, rapid expansion of invasive species, and disease outbreaks — all attributed at least in part to climate change — are challenging the management of natural resources throughout the world (TWS, 2005).

Even in Europe there are areas where the rising temperatures are accompanied by drying; meanwhile in other areas the amount of precipitation is increasing. In order to prepare for the approaching climate changes it is necessary to recognize what kind of climate and/or the frequency of natural disasters can be expected in the future. These changes can be studied by climate models projecting different long-term scenarios. On the basis of the model projections it is possible to evaluate the actual patterns of meteorological parameters as well as the expected future patterns. Making this distinction is important, because in many cases the real values don't agree with those projected by the climate models (e.g. seasonal patterns of precipitation in Hungary: SZALAI, 2010).

Furthermore, it should be emphasized that climate can't be forecasted with a high level of confidence and the probabilities are continuously changing as knowledge and understanding improves. In Hungary the temperature is increasing at a rate that is higher than the global average. This increasing tendency applies to the yearly averages and also to the seasonal means. The highest change is observed in the summers where it is >1 °C. In the case of precipitation the pattern is different, because, with the exception of summer, the average rainfall amounts are decreasing. One of the most significant consequences of the climate changes is the longer vegetation period, which is 1 week on the European level. This results in faster development of plants in the spring. As a consequence of the meteorological changes, the global and regional distribution of production sites, habitats, and optimal conditions can be shifted. This can be critical in case of species at the edge of the range, or it could open the way to range expansion for invasive species (SZALAI, 2010).

In Hungary, water (precipitation) is the primary limiting factor for agricultural production and natural ecosystems. As several elements of surface water supplies show unfavourable changes, this pattern will influence the habitats and living conditions of species living in areas used for agricultural production, forestry or reserved for nature conservation. According to the climate projections for 2050 and 2100, the climate in Hungary will be much drier, and in the case of woodlands, conditions favouring forest-steppe vegetation will occur (LÁNG ET AL., 2007). In the mid-21st century the humid zones of west Hungary will vanish and by 2100 the central parts of Hungary will be dominated by semiarid zone. It is important to stress that temperature and precipitation changes interact with soil changes and vegetation (DRUCZA AND ÁCS, 2004).

According to the latest ministerial decree, 32 species are listed as game species in Hungary. (FVM, 2010). Regarding the 8 big game species listed, five can be considered as important in game management and hunting (red deer, roe deer, fallow deer, mouflon, and wild boar). Of the 24 small game species, only four (brown hare, common pheasant, mallard, and red fox) have a country-wide range and larger management importance. Other small game species either have diminishing game management and shooting roles or their shooting bags are only locally important (waterfowl, pigeons).
The population sizes and the harvests of five big game species showed a considerable increase during the last half century (1960 - 2008/2009):

- Red deer - the population increased from 16700 to 87100 (521%) and the harvest from 3800 to 36200 (954%)
- Fallow deer - the population increased from 900 to 26700 (2967%) and the harvest from 100 to 9600 (960%)
- Roe deer - the population increased from 68800 to 350000 (508%) and the harvest from 37008 to 6100 (1251%)
- Mouflon - the population increased from 1400 to 10500 (752%) and the harvest from 200 to 2900 (1450%)
- Wild boar - the population increased from 8300 to 99300 (1197%) and the harvest from 3900 to 94400 (2420%)

At the same time, the most important small game populations declined seriously (1960 - 2008/2009):

- Brown hare- the population decreased from 1240000 to 524000 (44%) and the harvest from 508000 to 132000 (26%)
- Common pheasant - the population increased from 383000 to 795000 (208%) and the harvest from 97000 to 422000 (435%)[1]
- Grey partridge - the population decreased from 759000 to 37000 (5%) and the harvest from 100000 to 11000 (11%)[2]
- Wild ducks (mainly mallard) – their harvest declined from 90000 in early 1970s to 51000 in 2008 (56%).

Similar patterns of population trends of game species can be found throughout Europe. In general, the most common ungulates (big game) show marked population increases, especially roe deer, wild boar, and red deer (MILNER ET AL., 2006; BURBAITE AND CSÁNYI, 2009; APOLLONIO ET AL., 2010). Simultaneously with population increase, a fast range

[1] Here it should be noted that the maximum spring population was 2428 thousand pheasants recorded in 1978 and the maximum pheasant harvest was 1102 thousand in 1977. Since those times the trend of pheasant populations and harvests was the same as for brown hare and grey partridge.

[2] Only hand-reared and released birds are allowed to shoot. Consequently, partridge harvest is not related to the status of the wild populations.

extension of big game species occurred in Hungary. In case of red deer (CSÁNYI, 1999; TÓTH AND SZEMETHY, 2000), roe deer (CSÁNYI AND SZIDNAI, 1994), and wild boar (CSÁNYI, 1995) these were consequences of mostly natural population expansions. In case of fallow deer (TÓTH, 1991) and mouflon, (NÁHLIK, 1996) the expansion was assisted by deliberate introduction and establishment of fenced hunting enclosures (CSÁNYI AND LEHOCZKI, 2010). For the population increase of red deer, roe deer, and wild boar the following factors and their interactions can be proposed (APOLLONIO ET AL., 2010):

- Increasing forest cover providing more available habitat for big game species.
- Changes of agricultural land-use offering better habitat conditions for ungulates.
- More restrictive hunting legislation influencing hunting pressure (seasons, methods, number of hunters) and allowing ungulate populations to escape out of control.
- Ecological effects resulting from human activities and environmental changes, like climate change, locally or regionally improving the conditions for these species.

In case of small game species their declining trends can be accredited to human and/or environmental impacts (POTTS, 1986; FARAGÓ, 1997; CSÁNYI ET AL., 2006):

- Changes of agricultural technologies and land-use patterns reducing the biodiversity of farm-lands.
- Unfavourable changes in key habitats like wetlands and grasslands, important reproductive, migration, or wintering habitats of sedentary or migratory small game species.
- More restrictive hunting legislation influencing hunting pressure on predators, especially the full protection of birds of prey while not allowing the control of predators of small game.

It can be stated that the most important factors influencing game populations are directly or indirectly related to habitat changes. Climate changes are not explicitly included among these factors but cannot be avoided, including the short- and long-term effects they have on ecosystem processes. The synergistic, or combined, effects of habitat fragmentation and climate change represent one of the most potentially serious problems of global change (ROOT AND SCHNEIDER, 2002). The critical issue is no longer *if* climate change is occurring, but rather *how to address its effects on wildlife and wildlife habitats*. Although temperature variations can in some cases be localized and are often cyclical, evidence is accumulating that wildlife and wildlife habitats have been and will continue to be significantly affected by ongoing large-scale rapid climate change (TWS, 2005).

In Hungary several scenarios were evaluated in order to predict the potential impacts of climate change on biodiversity, agriculture, and forestry (LÁNG ET AL., 2007). Actually, the scenario of *rising temperatures accompanied by declining precipitation* (rainfall) is considered the most probable one. These slow processes can bring about considerable changes in the regional ecological systems of the Carpathian Basin. Regarding game, these can change the population dynamics and the distribution range of these species (FARAGÓ, 2005):

- Hydrological changes: the frequency of floods, inland inundation, drying and droughts, effects of drying on migrating species, shortage of surface water and its physiological effects.
- Vegetation changes: forest changes and their effects on big game, grassland changes and their effects on small game, arable land changes and their effects on game, and wetland changes and their effects on waterfowl.

It is necessary to remind that the knowledge about the potential climate induced impacts on game species are not well supported by comprehensive research but are based on anecdotal evidence or sporadic observation. In a shifting landscape, managing for the *status quo* becomes obsolete, and restoration of habitats may be unproductive. Effective planning for resource management instead requires being able to anticipate the impacts of climate change on plant and animal communities and to devise strategies to mitigate the changes or to adapt to them (TWS, 2005). This means that the current information available and the proposed changes/solutions should be treated carefully.

Regarding the hydrological changes, the drying periods of the past decades can serve as examples. Based on these it is expected that the migration routes of wild geese and ducks could be translocated out of the Carpathian Basin. Short distance movement of sedentary species can result in increasing predator pressure (wild boar), increased game damage around local water sources (big game), and increasing vehicle-wildlife collisions during movements (FARAGÓ, 2005).

Climate change will also influence the size and composition of Hungarian woodlands. This is especially important in the Great Hungarian Plain where mostly planted forests are found on edge sites and small changes in the climate regime may result in profound alterations. In these edge/suboptimal sites massive forest die-off occurred in less adaptive stands during the dying periods of the 1980s and 1990s. If these patterns are applicable for long-term climate changes in lowland forests these can be influential in the composition and productivity of future game habitats. Losses in zonal forests can be replaced with planted forests which will not influence the available forest area for game management. In some areas even the carrying capacity of the forests can be improved with more productive tree species and better understory vegetation (FARAGÓ, 2005).

In the case of grasslands and arable lands, irrigation can have adverse effects on wildlife species as a consequence of more intensive agricultural technology. Introduction of drought resistant plant varieties are not expected to cause serious habitat changes. If the crop rotation system changes fundamentally and lands are converted to grasslands or afforested the new game habitat can evolve. Grasslands can offer better living conditions for small game and forest blocks for big game. In the case of large-scale forest plantation projects, massive increase of big game habitats can be expected regardless of the tree species used. Based on results of the afforestation programs of the past decades it can be expected that 1 km^2 increase of the forest area results in the increase of deer and wild boar population by one individual. This process of deer population increase occurs at a threshold of 13-15% of forest cover (CSÁNYI, 1999).

In summary it can be concluded that available knowledge about the potential impacts of climate change is scarce in Hungary. Most of the assumptions are based on indirect evidence or uncontrolled observations. In order to be better prepared for the climatic changes focused research, more relevant information, and practical guidance are required. In 2007, the US Government Accountability Office summed up the problem facing resource managers as follows (cit. TWS and ESA, 2009): "*Resource managers have limited guidance about whether or how to address climate change and, therefore, are uncertain about what actions, if any, they should take. In general, resource managers lack specific guidance for incorporating climate change into their management actions and planning efforts. Without such guidance, their ability to address climate change and effectively manage resources is constrained.*"

On the basis of the North American example the following points may be applied to the situation in Hungary (TWS AND ESA, 2009):

- Forecasting wildlife and habitat responses depends on the ability to downscale climate models to temporal and spatial scales that will be useful to managers.
- Assess and synthesize the current state of scientific knowledge concerning climate changes and potential impact on wildlife and their habitats. Prioritize scientific gaps in order to forecast the ecological impacts of climate change on wildlife at the ecosystem, habitat, community, population, and species levels.
- Develop and improve tools to identify, evaluate, and link together different scientific approaches and models for forecasting the impacts of climate change and adaptation on wildlife and their habitats. Such tools include monitoring, predictive models, vulnerability analyses, risk assessments, and decision support systems to help managers make informed decisions.

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CAP REFORM AFTER 2013: FOOD SECURITY VERSUS ENVIRONMENTAL SECURITY

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INTRODUCTION

The sustained economic growth worldwide during the last two decades has shown the benefits of globalisation. However, with the current lower growth environment worldwide, unemployment rising and asset values deflating, etc, popular discontent will rise and may trigger nationalism, excessive self-interest and protectionism. Trade responsibility also means accepting special and differential treatment of developing countries in temporary trade protection so as to allow them to catch up with the more competitive industrialised and emerging count. Population growth (70 to 80 million more people a year, close to 9 billion by 2050) creates a rapidly growing demand for crop products including feed arising from increasing meat and dairy consumption. Moving production to the most competitive regions causes the food trade to become more liberalized and also more concentrated.

Climate change (and growing energy demand) will also influence food production; agriculture will contribute to emissions into the environment and also suffer or benefit from climate change, depending on climatic zones. Can we stop excessive borrowing from future generations in ecological and financial terms? The current crisis has shown that governments can act decisively and even effectively if extraordinary circumstances so dictate: we are not short of medicine (i.e solutions, capacity, funds), but we need the political will to apply it, which we usually only have when the crisis has manifested itself. Evidently, "the costs of earlier inaction" are much higher at that stage. Finally we face the question of who will pay for agricultural public services provided by land managers that the market does not pay for, such as rural landscape maintenance, environmental protection biodiversity, and animal welfare. These challenges are aggravated by global irresponsibility related to food security, water and environmental sustainability (and energy security).

Food security

The food crisis caught the world by surprise. Do we expect a new policy paradigm from open markets to protectionism, from food security to self sufficiency, from imports to outsourcing (land acquisition) and from private to public market intervention? More recent transnational land deals are partly a consequence of the larger changing economic valuation of land and water. Higher agricultural prices generally result in higher land prices because the expected returns to land increase when profits per unit of land increase. Given that the food price crisis has increased competition for land and water resources for agriculture, it is not surprising that farmland prices have risen throughout the world in recent years.

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An increasing number of countries are leasing and purchasing land abroad to sustain and secure their food production. Food-importing countries with land and water constraints but rich in capital are at the forefront of new investments in farmland abroad. Some agreements do not involve direct land acquisition, but seek to secure food supplies through contract farming and investment in rural and agricultural infrastructure, including irrigation systems and roads (BRAUN AND MEINZEN-DICK, 2009).

These include the acquisition of 690 000 hectares of land in Sudan by South Korea, and 324 000 ha of Pakistani land by the United Arab Emirates, as well as a pending Saudi request for 500 000 ha of Tanzanian land and Chinese attempts to secure more than one million hectares in the Philippines. A major evolution from past patterns is the transition from overseas profit oriented investments for tropical cash crops to farmland acqusition for growing basic staples, with an eye to bolstering a country's food security (Table 1).

Although additional investments in agriculture in developing countries by the private and the public sector should be welcome in principle, the scale, the terms and the speed of land acquisition have provoked opposition in some target countries (the Philippines, Madagascar). Well-documented examples on these developments are scarce and the lack of transparency limits the involvement of civil society in negotiating and implementing deals and the ability of local stakeholders to respond to new challenges and opportunities.

Table 1 **Transnational land acquisition, 2006-2009**

Country investor	Country	Plot size (hectares)
Bahrain	Philippines	10 000
China (with private entities)	Philippines	1 240 000
Jordan	Sudan	25 000
Libya	Ukraine	250 000
Qatar	Kenya	40 000
Saudi Arabia	Tanzania	500 000
South Korea (with private entities)	Sudan	690 000
United Arab Emirates (with private entities)	Pakistan	324 000

Source: Braun, von J., Meinzen-Dick, R. (2009). IFPRI has compiled this table from media reports. The responsibility for the accuracy of the information presented here, however, lies with the reporting media

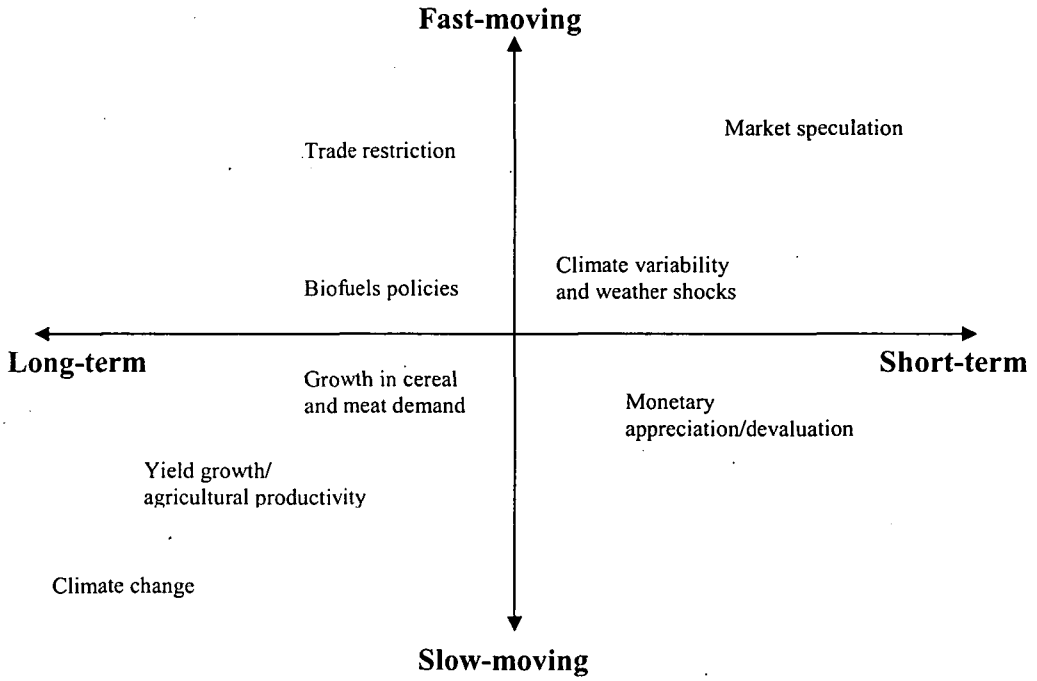
The main concerns today are the declining rate of food self-sufficiency and a growing sense of the potential for disruption to domestic food supplies in an uncertain world (climate change, energy security, -safety concerns over imported food, geopolitical tensions and the food price spike in 2008). There are long and short term factors and fast and slow-moving drivers leading to food crisis (Figure 1). There will always be risks associated with food supply and thus a need to manage these risks. European consumers are well placed to cope with price risk and well-functioning markets can help to reduce this risk. Domestic food supplies are not less risky than imports (energy) but it is sensible to plan for systemic risks (such as nuclear fallout, port strikes, etc.). We experience food poverty due to a lack of entitlements, not lack of food availability.

We face a future of food scarcity, with high, albeit very volatile prices both for inputs and outputs. Food scarcity is aggravated by managed trade and lack of finance and eventually also by environmental degradation. The market has lost its magic. Recent events have shown that markets can fail as deregulation has backfired. But open trade and related financing depend on it so a new financial architecture is urgent. We also need greater responsibility in budgetary and financial affairs. However, increased

government spending through stimulus packages poses a risk of plunging the world into a new crisis and sparking a return of inflation.

If there is going to be enough food at affordable prices for the global population we may also have to change our food habits and decrease food waste. Field losses amount to 20-40% due to pests and diseases. Food waste in the field pre-processing (broken grains, excessive dehulling), transport (spillage, leakage), storage (insects, bacteria) and processing and packaging (excessive peeling, trimming and inefficiency) goes up to 10-15% in quantity and 25-50% in value (quality). Marketing (retailing) and plate (by consumers and retailers) waste adds another 5-30% in developed and 2-20% in developing countries to the losses in the food chain (IWMI, 2007). We can save also water by reducing losses in the food chain.

Figure 1 **Relationships between the long/short term factors and fast/slow-moving drivers**



Source: International Food Policy Research Institute (2008)

By 2050 global food output needs to increase by about 70% due to higher food demand changing diets and urbanization. Urbanization will double domestic and industrial water use (not to mention climate change and bioenergy production). Without water productivity gains, crop water consumption will double by 2050. The water 'bubble' is unsustainable and fragile because 6.7 billion people have to share the same quantity as the 300 million global inhabitants of Roman times (Table 2). About 80% of water for food comes directly from rain but an increasing part is met by irrigation (IWMI, 2007).

A quarter of the world's population lives in closed or closing basins which are over-allocated with less environmental flows and more pollution. New development means taking water from current users downstream and new entitlements require re-negotiation of rights and reallocation of water. It means that no water is left for more development (Yellow River, Colorado, Amu/Syr Darya, Egypt's Nile, Lerma-Chapala, Jordan, Indus,

Krishna etc.). Another issue is how to reduce diversions? In India, 55-60% of farmers are dependent on groundwater irrigation. We need new governance in order to tame the anarchy ((IWMI, 2007).

Table 2 **Water use**

Use	Liters of water
Drinking water	2-5 litres per person per day
Household use	20-500 litres per person per day
Wheat	500-4,000 litres per kilo
Meat	5,000-15,000 litres per kilo
Biofuel	1,000-3,500 litres per litre
Cotton t-shirt	2,000-3,000 litres
Agriculture	3,000 litres per person per day 1 litre per calorie

Source: IWMI (2007) and Charlotte de Fraiture and David Molden: Balancing global water supply and demand. Presentation. Challenges for Agricultural Research, OECD, 6-8 April 2009 Prague, Czeh Republic

What are the challenges? We have to increase both the physical water productivity (more crop per drop) and economic water productivity (more value per drop) by investing in rainfed agriculture and irrigation. Water productivity improvement is feasible but farmers optimize land productivity rather than returns to water particularly where water is subsidized. We do not know what are adequate incentives but farmers in the EU are fighting for a higher irrigation water subsidy without impact analysis of water productivity improvement. Promoting food trade from water rich highly productive areas to water scarce areas contributes to global water productivity improvement.

There is good potential for new land cultivation in Latin America, Africa and Eastern Europe (Ukraine and Russia). However, new land is insufficient, and either inappropriate because of poor or polluted soils, or difficult to use for food production (due to doubtful property rights and/or poor finance and/or due to government mismanagement and lack of transportation infrastructure). Moreover, cultivated land is diminishing fast due to expanding deserts and urbanization. Global population growth (70-80 million people every year) claims nearly 3 million hectares for housing, roads, highways and car parks each year. The main reasons why world food supply is tightening are population growth and accelerated[4] urbanization, changes in lifestyles, falling water tables and diversion of irrigated water towards the cities (THE EARTH INSTITUTE, 2005).

To meet world demand, the necessary production growth will to a large extent have to be met by a rise in the productivity of land already farmed today. However, this will be difficult to accomplish because global agricultural productivity growth has been in decline since the Green Revolution of the 1960s and 1970s. Global crop yield increases plummeted from 4% per annum in the 1960s to 1980s to 2% in the 1990s and barely 1% in forecasts for 2000 to 2030. Despite substantial expected yield increases in India, United States, Russia, and the Ukraine, Europe's role as provider of food to the world is diminishing. The net crop trade position of the EU 27 can be expected to deteriorate. The EU's capacity to help fight world starvation will be reduced at a time when food production will decline

[4] An estimated 40,000 ha of land are needed for basic living space for every 1 million people added.

steeply in countries that already face increasing food import needs. Nevertheless, Europe will become a more secure production location in comparison to other world regions and higher food prices will boost deforestation there.

The discussion of food crisis has faded into the background-overshadowed by the global macroeconomic crisis and the financial crisis. The sharp rise in prices of basic foodstuffs created extreme difficulties for a large part of the world's population. The food crisis affected more people more severely than the macroeconomic issue because the populations most affected by sharply rising food prices spend larger shares of their income on food. The global food crisis produced an extraordinary human impact, larger and more adverse than the global financial crisis. One indication of the severity is the remarkable amount of recent civil unrest and political instability in dozens of countries (Ethiopia, Egypt, Mexico, Thailand) because people were unable to afford basic nutrition. Despite sharp falls in food prices since their peak in early 2008, prices of basic foodstuffs are still higher than they were in 2000. Along with the continuing upward trend of food prices, volatility is a clear problem. People do not eat at long intervals; they eat every day. Should high prices from 2008 return, the problem will be very serious because people are very vulnerable to high prices.

Environmental security

Many people are unaware of the speed with which we are consuming our natural resources. We are producing waste far faster than it can be recycled. It is important to compare the needs for public goods and services with arguments whether or not market failures are linked to the provision of services. We now know that the [over] exploitation of our entire ecosystem and the depletion of natural resources (the reserve-to-production ratio of oil reserves is rapidly declining) carry a price that must be paid today to compensate future generations for the losses (or costs of substitution) they will face tomorrow. Moreover, world population growth by 50% during the next 50 years, causing new scarcities (water) and pollution (CO_2 emission rights) is accelerating these issues. Corporations in energy-intensive sectors must start taking future CO_2 prices into account in their investment decisions and public disclosure policies now. Because the scarcity of emission rights has been recognized, an active market has been created in the EU. CO_2 emission rights now have a price; more regional cap and trade markets for CO_2 have been created in the U.S. and are in the process of development elsewhere.

The consensus about the importance of incorporating these "ecosystem services" into resource management decisions is increasing, but quantifying the levels and values of these services has proven difficult. Ecosystems markets will change the present, economics-only value paradigm that requires winners and losers. As an example, countries and companies with significant carbon-sink potential would benefit. Conversely applying the polluter pays principle, CO_2 emitters would pay to continue their emitting activities. The concept of limiting (capping), auctioning, and trading emission, access, and user rights must be further developed beyond CO_2, to include water and other resources on a worldwide scale. Valuing our ecosystems and regulating the access thereto will create a market for payment for ecosystem access entitlements and services. We must upgrade our performance metrics. The values of human and social capital, education, culture, social cohesion, and other factors should be established and more prominently involved in investment and development decisions.

Joseph Stiglitz and Nicholas Stern have made a joint appeal to use the financial crisis as an opportunity to lay the foundations for a new wave of growth based on the technologies for a low carbon economy (Financial Times, 2009). The investments would drive growth over the next two or three decades, ensuring it becomes sustainable. They added that "providing a strong, stable carbon price is the single policy action that is likely to have the biggest effect in improving economic efficiency and tackeling the climate crisis." Lord Stern calculated that governments should spend at least 20% of their stimulus on green measures to achieve the emission targets (STERN, 2006).

Mankind is directly influenced by the loss of biodiversity. Through the extinction of species we lose possibly crucial opportunities and solutions to problems of our society. Biodiversity provides us directly with essentials like clean water and air, fertile soil, and protects us from floods and avalanches. These aspects can all be economically valuated. It is a difficult and complex task, but through this valuation it becomes clear how important they are for human well being and economic development (Table 3).

Table 3 **Scenario of the future: 2050**

Actual	2000	2010	2050	Difference	Difference	Difference
Area	million km^2	million km^2	million km^2	2000 to 2010	2010 to 2050	2000 to 2050
Natural areas	65.5	62.8	58.0	-4%	-8%	-11%
Bare natural	3.3	3.1	3.0	-6%	-4%	-9%
Forest managed	4.2	4.4	7.0	5%	62%	70%
Extensive agriculture	5.0	4.5	3.0	-9%	-33%	-39%
Intensive agriculture	11.0	12.9	15.8	17%	23%	44%
Woody biofuels	0.1	0.1	0.5	35%	437%	626%
Cultivated grazing	19.1	20.3	20.8	6%	2%	9%
Artificial surfaces	0.2	0.2	0.2	0%	0%	0%
World Total	108.4	108.4	108.4	0%	0%	0%

Source: Cost of Policy Inaction, Braat et al., (2008)

Market failure is crucially important justification for taking measures to protect our landscapes. Corrections in market failures could also be achieved through investments and the provision of payments to reward land managers who provide public goods and services. It is important to demonstrate the economic value of ecosystem goods and services. We not only need to know costs, but also to be assured that the benefits are greater. There is increasing consensus about the importance of incorporating these "ecosystem services" into resource management decisions, but quantifying the levels and values of these services has proven difficult (EUROPEAN COMMISSION, 2008).

Our searches have revealed a disappointingly small set of attempts to measure and value these services. The first chronologically is the quantification of global ecosystem services by CONSTANZA ET AL (1997). Estimates were extracted from the literature of values based on willingness to pay for a hectare's worth of each of the services. These were all expressed in 1994 USD per hectare, there was some attempt to adjust these values across regions by purchasing power. The results were that the central estimate of the total value of annual global flows of ecosystem services in the mid 1990s was USD 33 trillion (ie 10^{12}) the range was thought to be USD 16-54 trillion. To put their figure into some kind of context, their central estimate was 1.8 times bigger than global Gross Domestic Product (GDP) at that time. We should take the figures only as the roughest of approximations – indeed the authors warn of the huge uncertainties involved in making calculations of this kind.

The "Stern Review" parallels the TEEB (see later) study into the economics of climate change (STERN, 2006). Climate change could have very serious impacts on growth and development. The costs of stabilising the climate are significant but manageable; delay would be dangerous and much more costly. The review estimates that if we do not act, the overall costs and risks of climate change will be equivalent to losing at least 5% of global GDP each year, now and forever. In contrast, the costs of action – reducing greenhouse gas emissions to avoid the worst impacts of climate change – can be limited to around 1% of global GDP each year. Key to understanding the conclusions is that as forests decline, nature stops providing services which it used to provide essentially for free. So the human economy either has to provide them instead, perhaps through building reservoirs, building facilities to sequester carbon dioxide, or farming foods that were once naturally available.

World Wildlife Fund's Living Planet Report" demonstrates that mankind is living way beyond the capacity of the environment to supply us with services and to absorb our waste (WWF 2008). They express this using the concepts of ecological footprints and biocapacity, each expressed per hectare per person[5]. Humanity's footprint first exceeded global biocapacity in 1980 and the overshoot has been increasing ever since. In 2005 they calculated the global footprint on average across the world was 2.7 global hectares (gha) per person[6] compared to a biocapacity they calculated as 2.1 gha/person, a difference of 30%. That is each person on earth, on average is consuming 30% more resources and waste absorption capacity than the world can provide. We are therefore destroying the earth's capacity and compromising future generations.

The study on "The Economics of Ecosystems and Biodiversity" (TEEB) is fundamentally about the struggle to find the value of nature. There are about 100,000 terrestrial protected areas on Earth, covering 11% of the land mass of our planet. These protected areas provide ecosystem services and biodiversity benefits to people valued at USD 4.4 trillion to USD 5.2 trillion (that is a million millions) per annum. That is more than the revenues of the global automobile sector, steel sector and IT services sector combined! Calculations show that the global economy is losing more money from the disappearance of forests than through the current banking crisis as forest decline could be costing about 7% of global GDP. It puts the annual cost of forest loss at between USD 2 trillion and USD 5 trillion. The figure comes from adding the value of the various services that forests perform, such as providing clean water and absorbing carbon dioxide. But the cost falls disproportionately on the poor, because a greater part of their livelihood depends directly on the forest, especially in tropical regions. The greatest cost to western nations would initially come through losing a natural absorber of the most important greenhouse gas (EUROPEAN COMMISSION, 2008).

The study shows that diversity is crucial for survival and the importance of biodiversity for economic development. It might be possible to substitute some of the ecosystem services by human-made technologies, but the study results clearly show that it is often cheaper to invest in the conservation of biodiversity than to invest into new technologies to substitute the services nature provides for us. Therefore it is essential for the safeguarding of our

[5] The Ecological Footprint "measures the amount of biologically productive land and water area required to produce the resources an individual, population or activity consumes and to absorb the waste it generates, given prevailing technology and resource management." (WWF, 2008)

[6] A global hectare is a hectare with a global average ability to produce resources and absorb wastes

natural resources to jointly create a coordination of economic interests. We need to give the ecosystem services of biodiversity a market value to create incentives for developing countries to conserve their biodiversity.

Market-based instruments are helpful to give the peoples of the world a chance to secure the natural resources and secure their livelihood simultaneously. In this context the inclusion of the private sector into the process of conservation and sustainable use of biodiversity has high priority. The goals of conservation and sustainability will only be achieved if the main drivers of ecosystem and biodiversity loss are actually addressed through appropriate intervention and response based on credible valuations. Businesses have to accept biodiversity as the indispensable resource which it is and to treat this resource with respect and care.

The Global Canopy Programme's report concludes: "If we lose forests, we lose the fight against climate change". International demand has driven intensive agriculture, logging and ranching leading to deforestation. Standing forest was not included in the original Kyoto protocols and stands outside the carbon markets. The inclusion of standing forests in internationally regulated carbon markets could provide cash incentives to halt this disastrous process. Marketing these ecosystem services could provide the added value forests need and help dampen the effects of industrial emissions. Those countries wise enough to have kept their forests could find themselves the owners of a new billion-dollar industry (PARKER ET AL., 2008).

Currently, there are two paradigms for generating ecosystem service assessments that are meant to influence policy decisions. Under the first paradigm, researchers use broad-scale assessments of multiple services to extrapolate a few estimates of values, based on habitat types, to entire regions or the entire planet (CONSTANZA ET AL., 1997). This "benefits transfer" approach incorrectly assumes that every hectare of a given habitat type is of equal value – regardless of its quality, rarity, spatial configuration, size, proximity to population centres, or the prevailing social practices and values. Furthermore, this approach does not allow for analyses of service provision and changes in value under new conditions. In contrast, under the second paradigm for generating policy-relevant ecosystem service assessments, researchers carefully model the production of a single service in a small area with an "ecological production function" – how provision of that service depends on local ecological variables (KAISER AND ROUMASSET, 2002). These methods lack both the scope (number of services) and scale (geographic and temporal) to be relevant for most policy questions (NELSON ET AL., 2009).

Spatially explicit values of services across landscapes that might inform land-use and management decisions are still lacking. Quantifying ecosystem services in a spatially explicit manner, and analyzing tradeoffs between them, can help to make natural resource decisions more effective, efficient, and defensible (NELSON AT AL., 2009). Both the costs and the benefits of biodiversity-enhancing land-use measures are subject to spatial variation, and the criterion of cost-effectiveness calls for spatially heterogeneous compensation payments (DRECHSLER AND WAETZOLD, 2005). Cost-effectiveness may also be achieved by paying compensation for results rather than measures. We have to ensure that all the possibilities to create markets to provide environmental services are fully exploited to minimise the public costs (and the extent of government bureaucracy etc).

Creating markets for environmental services could encourage the adoption of farming practices that provide cleaner air and water, and other conservation benefits. Products expected to generate the greatest net returns are the ones generally selected for production. Since environmental services generally do not have markets, they have little or no value when the farmer makes land-use or production decisions. As a result, environmental services are under-provided by farmers. The biggest reason that markets for environmental services do not develop naturally is that the services themselves have characteristics that defy ownership. Once they are produced, people can "consume" them without paying a price. Most consumers are unwilling to pay for a good that they can obtain for free, so markets cannot develop. Can anything be done other than relying on government programmes to provide publicly funded investments in environmental services?

Creating markets for environmental services is not an entirely novel idea. Governments play a central role in setting them up as has been done for markets in water quality trading, carbon trading and wetland damage mitigation. These markets would not exist without government programmes that require regulated business firms (such as industrial plants and land developers) to meet strict environmental standards. In essence, legally binding caps on emissions (water and carbon) or mandatory replacement of lost biodiversity (wetland damage mitigation) create the demand needed to support a market for environmental services. So-called cap and trade programs create a tradable good related to an environmental service (RIBAUDO ET AL., 2008).

Mandatory reduction pledges can be experienced in all developed nations apart from the USA. The same is true for project-level reductions in developing countries. Mandatory cap-and-trade programmes have been introduced in the Northeastern USA and the EU. The United States and Australian governments will also institute a mandatory cap and trade programme to create financial incentives to limit energy use or reduce emissions. In the case of water quality, it is necessary to establish caps on total pollutant discharges from regulated firms in some watersheds, and issue discharge allowances to each firm specifying how much pollution the firm can legally discharge. In markets for greenhouse gases, carbon credits are exchanged. Contracts also include renewable energy credits and voluntary carbon credits. No-net-loss requirements for new housing and commercial development require that damaged/lost wetland services be replaced, creating demand for mitigation credits, which are produced by creating new wetlands. In all of these cases, the managing or regulatory entity defines the tradable good and enforces the transactions.

Simply creating demand for an environmental service does not guarantee that a market for services from agricultural sources will actually develop. A number of impediments affect agricultural producers' ability to participate in markets for environmental services. Purchasers may be unwilling to enter into a contract with a farmer who cannot guarantee delivery of the agreed-upon quantity of pollution abatement, wetlands services or other environmental service. Some markets prevent uncertain services from being sold. For example the Chicago Climate Exchange does not certify credits from soil types for which scientific evidence is lacking on the soil's ability to sequester carbon. Transaction costs can also undermine the development of markets for environmental services (RIBAUDO ET AL. 2008).

If markets are to become important tools for generating resources for conservation on farms, government or other organizations may have to help emerging markets overcome uncertainty and transaction costs. Government can reduce uncertainty by setting standards

for environmental services. Government can play a major role in reducing uncertainty by providing research on the level of environmental services from different conservation practices. For example, the government can develop an online Nitrogen Trading Tool to help farmers determine how many potential nitrogen credits they can generate on their farms for sale in a water quality trading programme.

While markets have many desirable properties, they are limited in what they can accomplish, even with government assistance. Public good characteristics that defy ownership discourage markets for environmental services from developing – and prevent the full value of environmental services from being reflected in prices. The prices of credits in water, carbon, and wetland markets also may not reflect their full social value, only their value to the regulated community. A national cap-and-trade programme could establish a national market for carbon credits. Others, such as water quality trading or wetland damage/loss mitigation, may be limited to a few specific geographic areas.

A significant role should be given for EU policy and budget in the appropriate land and environmental management. The EU needs regulation defining its policy on markets for environmental services. This policy would cooperate with MS and local governments to establish a role for agriculture in environmental markets. We have to find ways to make EU policies and programmes support producers wanting to participate in such markets. Conducting research and developing tools for quantifying environmental impacts of farming practices is of great importance as well. Requirements are needed to establish technical guidelines for measuring environmental services from conservation and other land management activities, with priority given to participation in carbon markets. Guidelines are also to be established for a registry to record and maintain information on measured environmental service benefits, and a process for verifying that a farmer has implemented the conservation or land management activities reported in the registry.

"Ecosystems" markets will change the present, economics-only value-paradigm, with winners and losers. As an example, countries and companies with significant carbon-sink potential will benefit. On the other hand, applying the "polluter-must-pay" principle, CO_2 emitters must a pay a price for continuing to be able to do so. The concept of limiting (capping), auctioning and trading emission/access/user rights must be further developed beyond CO_2, in scope (e.g. water) and scale (worldwide). On the basis of valuing our ecosystems and regulating the access thereto a market will be created for payment for ecosystem-access entitlements and for ecosystem services. We really need to upgrade our performance metrics. The same is true with respect to Human/Social Capital: also here the metrics, the value of education, culture, social cohesion, etc. should be established and more prominently included in investment/development decisions.

Energy security

Energy prices have seen a decline (in constant dollars) over the past 200 years. The latest energy price hikes have not even brought us back to the price levels of some 30 years ago. The tragic reality is that political zeal led governments to keep energy prices as low as possible, thus frustrating most attempts to increase energy productivity. Energy price elasticity is very much a long-term affair, and return on infrastructure investments crucial to the creation of an energy-efficient society requires time. Creating a long-term trajectory of energy prices that slowly, steadily and predictably rise in parallel with energy productivity would give a clear signal to investors and infrastructure planners that energy efficiency and productivity are both necessary and profitable.

Much debate surrounds the potential contribution of agriculture to renewable energies. Unfortunately, existing technologies produce energies that may be renewable, but most are not green. Whether second generation biofuels may eliminate most of the pitfalls of the first generation is open to doubt, although they include saving food components of plants. Biofuel policy is a major aggravating factor even if it is now in the background because of the decline in oil prices that reduced the demand and the drops in food prices. The current economic crisis is now the focus of attention, but renewable energy will return as a problem with increasing oil prices when the crisis ends (KRUGMAN, 2009).

CONCLUSIONS

In 2008, the issue of sharply rising food prices was at the top of the agenda. International trade in commodities futures has expanded enormously and food prices went up very sharply, commodity prices went up very sharply and then fell a great deal. The discussion of the food crisis has faded in to the background because it has been overshadowed by the global macroeconomic and the financial crisis. With an economic slump, the real price of commodities always falls and vice versa. The current fall in prices is the consequence of a global recession. With the end of the crisis, resource constraints plus bad polices are creating a major problem for the supply of food in the world. Despite the sharp fall in food prices since their peak in early 2008, prices of basic foodstuffs are still higher than the beginning of this decade. Aside from the level of food prices still on an upward trend, the volatility is a clear problem as people are very vulnerable to such high prices.

We face three global crises. They concern the food, energy, environment (and finance). At present the sharpest of them is the current financial collapse but the most frightening is the looming food crisis. With the end of recession we are back in a world that has growing population, growing purchasing power, and growing consumption of foods that are very intensive in the use of cereals, for example meat uses a lot more basic agricultural production than the consumption of grain. Water is a concern and so too is the use of potential arable land. To the extent climate changes, most agricultural patterns may become disrupted. The environmental resource scarcity issue is also a real challenge. Climate change is alarming because of its different and greater scale of risk. They are interconnected. For instance, without a greater and more stable food economy meeting the Kyoto goals against climate change is impossible. Much debate surrounds the potential contribution of agriculture to renewable energies. Biofuel policy is a major aggravating factor even if it is now in the background because of the decline in oil prices that reduced the demand and the drops in food prices. The current economic crisis is now the focus of attention, but renewable energy will return as a problem with increasing oil prices when the crisis ends.

The traditional Common Agricultural Policy objective of food security will remain in place, although there is an increasing acknowledgement of the need to address social and environmental values too. In the future, agricultural policy will need to respond to public demands linked to the maintenance of landscapes, the conservation of natural resources and biodiversity, food safety and sustainability. However, more suitable strategies are needed to achieve greater social legitimacy, as well as international recognition, for the system of support.

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ANALYSIS OF THE EFFICIENCY OF INTERMEDIARY CONSUMPTIONS FROM AGRICULTURE IN NATIONAL AND EUROPEAN CONTEXT

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ABSTRACT - Analiza eficienței consumurilor intermediare din agricultură în context național și european

Scopul urmărit în această lucrare este investigarea principalilor indicatori care reflectă nivelul și tendințele eficienței activității economice din agricultură sub impactul transformărilor care s-au produs în această ramură și în economia națională în perioada postdecembristă și având în vedere statutul României de stat membru al Uniunii Europeane. Prin ponderea pe care o deține în economia națională (agricultura participă la formarea Produsului Intern Brut în proporție de 5,7%, comparativ, de exemplu, cu Germania unde această valoare este de 1%), dezvoltarea acesteia este într-o măsură mai mare dependentă de agricultură, comparativ cu alte țări. Este și rațiunea pentru care considerăm dezvoltarea agriculturii printre cele mai importante priorități ale actualei perioade, ca suport pentru relansarea dezvoltării economiei naționale. În ce măsură agricultura evoluează în direcția dorită, dacă aceasta reprezintă un factor de stimulare a dezvoltării economiei naționale și de apropiere de nivelul atins de agricultura altor țări europene sunt întrebări ale căror răspunsuri depind de nivelul și evoluția eficienței activității economice.

ABSTRACT - Analysis of the efficiency of intermediary consumptions from agriculture in national and European context

The objective of this work is the investigation of the major indicators reflecting the level and trends of the efficiency in agricultural economic activity, under the impact exerted by the changes occurred in this field and in the national economy during the post-Revolution period, with consideration on the Romania's status as European Union member state. With agriculture's proportion in the national economy (agriculture participates to Gross Domestic Product formation in a proportion of 5.7%, compared with Germany for example, where this value is 1%), the development of this depends much more on agriculture compared with other countries. This was the reason why we consider that agricultural development is one of the most important priorities at the moment, as support for the refreshment of the national economy development. Does agriculture evolve in the right direction, does it represent a factor that stimulates the national economy development or that approaches the level reached by agriculture in other European countries – these are questions whose answers depend on the level and evolution of the economic activity efficiency.

Cuvinte cheie: eficiență, consumuri intermediare, producție, valoare adăugată brută

Keywords: efficiency, intermediary consumptions, production, gross value added

INTRODUCTION

Intermediary consumptions represent the consumptions of economic goods, excepting the fixed capital, used to produce other goods. In agriculture, such goods are: biological material, chemical and organic fertilizers, insecticides and fungicides, fuels and lubricants, water and electric energy, forage, veterinary medicines and other raw matter and materials. Some of them are achieved from the agricultural production; the others are supplied by non-agricultural fields.

In Romania's agriculture, the intermediary consumptions, in real terms, have recorded a slight decline that started before 1989 and got more significant during the following years.

Romania provides inputs in a small amount, because of the lack of capital. The capital represents a major factor limiting the increase of agricultural production. The agricultural structures' character of subsistence and the lack of capital-developing resources, at the moment in Romania, produce a blockage in the technical and technological holding modernization.

MATERIAL AND METHOD

In the assessment of the macroeconomic efficiency of agricultural activity, an important role is played by the analysis of the relationship between yield and gross value added, compared with the intermediary consumptions, respectively GVA per 1 ha of agricultural area used.

To determine these indicators, we used data taken from the European Commission statistics (Eurostat); successively, we processed and observed on these data in order to draw conclusions.

RESULTS

During the last 20-30 years, Romanian agriculture has recorded a significant decrease of intermediary consumptions. The consumptions of fuels, chemical and natural fertilizers, and the other consumptions necessary for agriculture are below the level required by the good results in this field. In table 1, we present some significant data regarding the final consumption of chemical fertilizers in Romania and in the other European Union-member countries.

Table 1: Chemical fertilizers used in Romania and EU

Countries	Chemical fertilizers (kg s.a. / arable ha)	RO:UE	Cereal yield (kg/ha)	RO:UE
EU	**151**	**1:4.3**	**4820**	**1:1.5**
Belgium	..	..	8740	1:2.6
Denmark	130	1:3.7	6150	1:1.8
Germany	220	1:6.3	6490	1:1.9
Ireland	545	1:15.6	6900	1:2.1
Greece	148	1:4.3	3540	1:1.1
Spain	161	1:4.6	2170	1:0.6
France	215	1:6.1	6980	1:2.1
Italy	169	1:4.8	5380	1:1.6
Luxembourg	..	..	5630	1:1.7
The Netherlands	370	1:10.6	8380	1:2.5
Austria	149	1:4.3	6150	1:1.8
Portugal	115	1:3.3	2040	1:0.6
Finland	134	1:3.8	3420	1:1.0
Sweden	99	1:2.8	4980	1:1.5
Great Britain	306	1:8.7	7220	1:2.2
Czech Republic	120	1:3.4	4750	1:1.4
Estonia	32	1:0.9	2690	1:0.8
Cyprus	157	1:4.5	1130	1:0.3
Latvia	27	1:0.7	2800	1:0.8
Lithuania	66	1:1.9	2940	1:0.9
Hungary	109	1:3.1	5530	1:1.7
Malta	88	1:2.5	..	..
Poland	108	1:3.1	3230	1:0.9
Slovenia	..	..	6030	1:1.8
Slovakia	86	1:2.5	4480	1:1.3
Bulgaria	47	1:1.3	3390	1:1
Romania	**35**	**1:1**	**3320**	**1:1**

Source: Calculated according to FAO Statistics Division

Crop fertilization is a factor of major influence on yield level. It is known that we cannot obtain big and safe yields without fertilization, even on the most fertile soils. The experiences performed in our country and abroad as well proved that the maximal yields that can be obtained without fertilization are 2500-3000 kg/ha (OTIMAN P.I., 2002). Consequently, the chemical and organic fertilization is a necessity, a condition to have constancy in the agricultural production.

The data in this table explain the causes of the disproportion between the mean yields from Romania and the EU countries. Moreover, if we mention that the most EU countries use annually the entire amount of organic fertilizers as solid manure or liquid, than we obtain another support for yield level, especially in cereals and pastures.

The amount of chemical fertilizers used in the Romanian agriculture has been reduced, during 1989-2008, for about three times; in 2008, we used 36 kg active substance per 1 ha of arable land compared with 78 kg in 1989. The amount of natural fertilizers has been reduced in the same way, as effect of livestock reduction. As a result, the available soil nutrients and land's productive capacity decreased, as well.

Table 2: Efficiency of intermediary consumptions in Romania's agriculture

Years	Production (mil. Euro)	Intermediary consumption (mil. Euro)	Gross value added – GVA (mil. Euro)	Production per 1 Euro intermediary consumption	GVA per 1 Euro intermediary consumption
1998	9783.76	4631.33	5152.43	2.11	1.11
1999	7780.06	3560.39	4219.66	2.18	1.18
2000	8067.10	3850.11	4216.99	2.09	1.09
2001	10707.14	4998.23	5708.90	2.14	1.14
2002	10100.69	4902.73	5197.96	2.06	1.06
2003	10761.85	5108.41	5653.44	2.10	1.10
2004	13654.44	6462.18	7192.26	2.11	1.11
2005	12853.03	6664.07	6188.96	1.93	0.93
2006	14365.42	7348.03	7017.39	1.95	0.95
2007	14312.26	8047.12	6265.15	1.78	0.78
2008	18216.75	9837.91	8378.84	1.85	0.85
2009 (e)	15161.26	8302.49	6858.77	1.83	0.83

(e) estimated value
Source: Calculated according to EUROSTAT – online help „Economic Accounts for Agriculture"

A similar reduction may be observed on the amounts of insecticides, fungicides and herbicides. The main cause of the reduction of fertilizers and other chemical substances is represented by the increase of prices, under the lack of financial resources for purchase.

The efficiency of intermediary consumptions' utilization in the Romanian agriculture, expressed by yield and gross value added reported to the intermediary consumption, has recorded a decrease in both cases and it is presented in table 2.

The intermediary consumptions from the Romanian agriculture represent another sensible point, deviated from normality, in comparison with the situation available in the advanced states. In order to assess correctly the level of intermediary consumptions and their economic efficiency, it is necessary to compare them with the situation in the EU and in the member states.

Table 3: Efficiency of intermediary consumptions in the European Union agriculture (2008)

Countries	Agricultural production (mil. €)	Intermediary consumption (mil. €)	Gross value added (GVA) (mil. €)	Intermediary consumption / production %	Production per 1 € Intermediary consumption -euro-	Intermediary consumption per 1 ha agr. area used (€)	GVA per 1 ha agr. area used (€)
EU-27	381212	228898	152314	60.04	1.66	1326	882
EU-15	315900	188265	127635	59.59	1.67	1510	1024
BE	7485	5480	2005	73.21	1.36	3987	1458
DK	9090	7571	1519	83.28	1.20	2843	570
DE	49852	34299	15553	68.80	1.45	2025	918
IE	6114	4494	1620	73.50	1.36	1085	391
GR	11011	4947	6064	44.92	2.22	1213	1487
ES	43183	19200	23983	44.46	2.24	771	963
FR	69211	41919	27292	60.56	1.65	1525	993
IT	47641	21614	26027	45.36	2.20	1695	2042
LU	330	219	111	66.36	1.50	1673	848
NL	24013	16021	7992	66.71	1.49	8369	4174
AT	6691	3812	2879	56.97	1.75	1195	902
PT	7037	4943	2094	70.24	1.42	1423	603
FI	4568	3544	1024	77.58	1.28	1546	446
SE	5005	3656	1349	73.04	1.36	1145	422
UK	24670	16544	8126	67.06	1.49	1025	503
CZ	4764	3552	1212	74.55	1.34	1009	344
EE	668	446	222	66.76	1.49	491	244
CY	648	347	301	53.54	1.86	2376	2061
LT	2302	1561	741	67.81	1.47	589	279
LV	1044	748	296	71.64	1.39	421	166
HU	7825	5211	2614	66.59	1.50	1232	618
MT	136	80	56	58.82	1.70	7744	5421
PL	21838	13895	7943	63.62	1.57	897	514
SI	1106	696	410	62.92	1.58	1423	838
SK	2270	1649	621	72.64	1.37	851	320
BG	4494	2608	1886	58.03	1.72	854	618
RO	18217	9838	8379	54.00	185	715	609

Source: Calculated according to EUROSTAT – online help „Economic Accounts for Agriculture"

CONCLUSIONS

By analyzing the data in table 3, we may draw the following conclusions:

a) The percentage of intermediary consumptions in the final agricultural production ranges between 44.46% in Spain and 83.28% in Denmark. 12 of the EU-15 countries have percentages that are superior to the Romanian one, and three of them are inferior. Of the other member states, only one country has a percentage that is inferior to the Romanian one (Cyprus).

b) Regarding the economic efficiency expressed by final agricultural production reported to intermediary consumptions (respectively, final agricultural production obtained per 1 euro), 12 countries (from EU-15) achieve levels that are reduced compared with Romania, and three – superior levels. The best efficiency is obtained by Spain (2.24 euro production per 1 euro intermediary consumptions), and the smallest one is obtained by

Denmark (respectively 1.20/1 euro). Of the new member states, only Cyprus overtakes the level of this indicator obtained in Romania.

The situation in Romania is very similar with the EU mean in terms of intermediary consumptions' percentage in the agricultural production, and also regarding the proportion GVA/intermediary consumption.

The gaps appear and they are very big if we analyze the level of intermediary consumptions per unit of surface used and compared with the level of final agricultural production and with the obtained gross value added.

Because Romania has intermediary consumptions per ha of only 715 euro, it is overtaken by all the old EU member states and by the new ones, as well, excepting Latvia, Lithuania and Estonia. The intermediary consumptions per ha are bigger with 11.7-fold in The Netherlands, 5.6-fold in Belgium, 4-fold in Denmark and 2.8-fold in Germany than in Romania. EU-15 allocates, for the intermediary consumptions, a mean value that is 2.1-fold bigger than Romania. The value added per ha is also remarkably bigger than in Romania: 6.8-fold in The Netherlands, 3.3-fold bigger in Italy, 2.4-fold in Belgium and Greece and 1.6-fold bigger in France; the EU mean is 1.7-fold bigger. The big gaps between Romania and the EU member states regarding the mean production and the gross value added rely especially on much bigger intermediary consumptions. This comparison is also available in the case of the new member states, because Romania is overtaken by almost all the EU countries when we speak about the gross value added per ha, excepting the Baltic countries.

The unfavourable situation from Romania, in terms of intermediary consumptions per ha, presents the advantage of having a „cleaner" soil, favourable for the development of the ecologic agriculture; this would represent a real chance for the advancement of Romania in the hierarchy of countries from such an important field, from an economic and social viewpoint.

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Eurostat Website: http://ec.europa.eu/eurostat

European Commission: http://ec.europa.eu

SOUTH MORAVIAN COUNTRYSIDE: PROGRESS OR STAGNATION?

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ABSTRACT – South Moravian countryside: progress or stagnation?
Countryside may be also conceived of as a territory of lower population density. In this regard the fields and forests take up roughly 90% of the South Moravian Region. Other activities outside the urban area of the city of Brno are marginal, they can however constitute inappropriate dominant features or barriers in the landscape. The countryside as a social system is conversely subject to urbanization; this also applies to the periphery. Rather those countryside features have a better chance of survival, which are associated with a lower number of inhabitants of rural settlements, while those related with work in agriculture are quickly vanishing. The following trends and challenges can be anticipated in future: continuing suburbanization, counter urbanization and amenity migration, growing significance of leisure time and its impact on learning recreation, decreasing share of the primary industries and a rising proportion of services in the employment structure, growing importance of nature and landscape conservation, population ageing and development of services for senior citizens, internationalization, globalization and the demise of the barrier effect of the national border. It is of significance that the countryside provides alternative ways of living for the current population.

INTRODUCTION

Half a century ago, countryside used to be a symbol of backwardness and stagnation in contrast to the city which stood for progress and better quality of life. In the last fifty years, however, the perception of European countryside has seen remarkable changes in the direction from west to east. Although without any doubt social progress continues to be formed primarily in the cities, where the educational, research and development institutions are concentrated, the countryside plays an ever increasing role in the life of the society.

The Czech countryside naturally develops within the framework of the European and global trends. Concurrently some historical, natural and geographic specificities come into play, too. In the second half of the 20th century, the Czech village has gone through the stage of socialization and industrialization of farming marked by several specifics even in the context of the Eastern socialist camp. The South Moravian countryside is noteworthy due to relatively favourable natural conditions for intensive farming and it is exceptional because of its location in the theoretically most backward south-eastern corner of the state.

The following account originated in the process of addressing the EU DERREG 7th Framework Programme No. SSH-CT-2008-225204 titled "Development of the Europe's Countryside in the Era of Globalization". Within the scope of this programme, the South Moravian Region is compared to other nine case regions in other European countries. In such a comparison the South Moravian Region appears to be very rural and if we look at it from the perspective of the GDP per person, it ranks as a rather poor region of NUTS 3.

In reality the South Moravian countryside generally does not seem to be perceived as such. Is it the system of Europe-wide indicators or other values considered further in the context of regional, national and central European measures that matter in the evaluation of

regional advancement? What is more important – the hard data or the perception of the region by its inhabitants and visitors?

THEORY AND METHODS

Countryside is one of those terms with which everybody assumes to be familiar but which is extremely difficult to define accurately (WOODS 2005). HALFACREE (1993) categorizes the definitions of the countryside into two groups. The first one attempts to characterize the corresponding type of rural locality. The second group is based on a socio-cultural interpretation. It now appears, in the post-modern times, that the non-material definition may dominate its locality-based alternative.

The OECD methodology (also used by Eurostat) defines countryside as a territory of a density lower than 150 persons per square kilometre. But this definition does not consider the regional specificities that matter more in the rural space than in the cities. The Czech Statistical Office definition specifies that rural municipalities are those with less than 2,000 inhabitants and municipalities of up to 3,000 inhabitants unless they are settlements of at least an administration district of a municipality with extended competence or of a higher territorial unit. With respect to the remarkably different settlement structure of the South Moravian Region the regional administration of the Czech Statistical Office[7] accepted a definition stating that rural space is constituted by municipalities with less than 4,000 inhabitants, including three towns formed by a larger number of small settlements.

According to this definition the rural space of the South Moravian Region is constituted by 647 municipalities with 44.2% of the population (2003–2007 average). These municipalities took up 96.1 % of the Region's surface area. If we return to the OECD definition, the South Moravian Region is a strongly rural space. If we do not include the city of Brno, the people living in the rural municipalities would constitute two thirds of the Region.

Measuring the regional advancement or stagnation is by no means a simple issue. Economic and demographic aspects, environmental situation, quality of life and probably a series of other perspectives are brought into play. A certain assessment was attempted by PERLÍN AND ŠIMČÍKOVÁ (2006) or by BAŃSKI (2008), who singled out factors of location and socio-economic and technical-organizational factors.

Experience attests to the fact that a significant proportion of the region's development must be attributed to its centre. In this regard we need to consider the function of the city of Brno, the second largest in the Czech Republic and a prominent university, commercial and transport centre.

While the system of economic and demographic indicators at the level of a region, districts and frequently also municipalities is elaborated to a great degree of detail, the assessment of the environment and standard of living is rather complicated. It is quite obvious that in most cases we cannot make do with hard data. Since at this moment we still do not know the questionnaire survey results of the project, we can only speculate about the actual situation.

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[7] The position of countryside within the South Moravian Region. The Czech Statistical Office Brno 2009, p. 171.

The countryside is apparently fairly differentiated. Within the national framework, we can hypothetically distinguish between the countryside of Bohemia and Moravia and the countryside of the interior and the borderland. Of significance are also conditions peculiar to each location (distance from the centre) and the natural characteristics. This also applies to the South Moravian countryside which includes the suburbanized countryside in the environs of Brno, the peripheral countryside in the border areas, the internal periphery and the countryside of the South Moravian vales with a substantial proportion of grapevine and fruits cultivation.

The momentum of the hitherto countryside conception in the central European context is associated with agriculture (a representative example for many others is BIČÍK AND JANČÁK 2006). As a matter of fact, in today's Europe the primary activities in the countryside still have a strong representation in the land use but their importance in terms of employment, economy and way of life is quickly waning. We still more often refer to multifunctional countryside, to its urbanization and changing conception (CLOKE ET AL. 2006).

SOUTH MORAVIAN COUNTRYSIDE

The South Moravian countryside is tackled within the framework of the South Moravian Region which is a state administration and self-governing unit of NUTS 3 in compliance with the EU terminology. The Region's surface area is 7,195 km^2 and the population totals 1,147,000 which results in a mean density of 159 persons per km^2. The city of Brno has 370,000 inhabitants on a surface area of 230 km^2. The remaining area is thus characterized by a population density of 112 inhabitants per km^2.

The population of the rural municipalities of the South Moravian Region was half a million. On average a rural municipality had 783 inhabitants. The most common were medium-sized municipalities with 500–999 inhabitants. The majority of the population (almost one third) lived in large rural municipalities of over 2,000 inhabitants. Roughly one third of the rural space was characterized by the population density lower than 50 persons per km^2 and another one third by a density of 50–99 persons per km^2.

In terms of land use, the farm land constituted 63.6%, forest land 26.0% and built-up areas 1.6% of the surface area. From the national perspective the Region's proportion of agricultural areas is above the average and the share of forest areas conversely deeply below it. The coefficient of ecological stability[8] results more favourable (0.76) for the South Moravian towns (with the share of forests at 30%) than for the countryside (0.62).

Remoteness tends to be measured by the accessibility of the nearest centre. The seats of administrative districts (put plainly, the nearest towns or central villages) are accessible by road within 30 minutes for 92.6% of the rural inhabitants. Brno is accessible for 21.4% of the population of the South Moravian countryside within 30 minutes, while for 24.2% of the inhabitants within a period exceeding one hour. The frequency of the public transport lines is important, too. The majority of the territory is nowadays covered by the Integrated Public Transport System, which associates 20 carriers. The system covers 513 municipalities and 1,030,000 inhabitants by 289 lines. It assures high frequency, regularity and low transfer waiting times of the lines also during weekends and holidays.

[8] Ratio of ecologically stable and unstable areas.

Although the population of the South Moravian countryside is subject to ageing[9], it is on average still younger in comparison with the Region's towns. The age category of 0–14 years constitutes 14.8% of the population, while inhabitants over 65 or older constitute 14.7% (16.2% in the cities) of the total. The average age in the South Moravian countryside is 40 years and 41.4 years in the South Moravian towns. An approximate degree of natality as well as a general fertility rate were slightly lower in the countryside than in the towns but the countryside showed remarkably lower percentages of children born out of wedlock and abortions (including miscarriages).

Mortality was slightly higher in the countryside than in the towns (10.5 and 10.3 of deceased per one thousand inhabitants). Variations consisted in the causes of death: circulatory system illnesses prevailed in the countryside and tumours in the cities. The countryside was characterized by a higher natural decrease of the population (0.9‰) than the towns. On the contrary, the countryside witnessed a population increment of 6.3‰ due to migration to which corresponds the total positive balance (5.4‰) of residential mobility. Towns had a negative tendency also in terms of migration. As a result in the last period the share of rural population in the South Moravian Region increased.

A notable difference to the detriment of the countryside rests in the educational structure of the population above 15 years of age[10]. Elementary education and completion of apprenticeships without the GCSE examination (71.2% compared to 52.7% in the towns) considerably predominate in the countryside. This relationship becomes inverted in the case of secondary and higher education. The proportion of university graduates residing in the countryside is only 5% as opposed to 14% in the towns.

This correlates with the lower entrepreneurial activity of the rural population. The rural space of the South Moravian Region has 199 economic entities and 108 active enterprises per 1,000 inhabitants (as of 2008). Budgets of the rural municipalities dispose of CZK 15,500 per inhabitant, while in the towns it is double the amount. Quite surprisingly, the countryside has more beds in accommodation facilities per thousand inhabitants (29.9) than the urban areas. However, if we look at the development trend, the relative growth of the number of economic entities between 2001 and 2008 was clearly higher in the countryside. Yet the towns were marked by a higher growth of entities in the primary sector and in enterprises associated with primary production, while the countryside saw a higher growth intensity in services.

THE FUNCTION OF THE SOUTH MORAVIAN COUNTRYSIDE

Up until recently primary activities were considered as the traditional countryside's function, i.e. chiefly agriculture and forestry complemented – based on the concrete conditions – by water management and extraction of mineral resources. At present the countryside is being attached the importance of a space for tourism and recreation and also for nature conservation. In connection with the development of suburbanization and counter urbanization additionally the residential function and the related communal enterprising become asserted. Furthermore, other branches such as industry, power engineering, commerce and services are gaining ground in the countryside.

If we wish to discuss the rural functions, we need to get over the original dichotomy. On the one hand the countryside can be perceived as a territory, and on the

9 The population data are an average for the years 2001–2008.
10 Population and Housing Census 2001

other as a social system determined mainly by the typical way of life. If we talk about the rural functions in the first sense, then land use is decisive. It is obvious that primary activities are still performed on by far the largest proportion of the rural areas – in our case they account for roughly 90%. Other activities may form inappropriate dominant features in the area (e.g. wind power plants) and barriers (e.g. transport structures) or otherwise alter the aspect of the landscape (e.g. solar power plants), but their areal extent is negligible. The cultivation structure may also incline towards the so-called "energy crops". As for its function, the South Moravian countryside remains characterized by farming and forestry.

According to the second group of criteria the South Moravian countryside – including even its peripheral parts outside the suburbanization zones – is subject to extensive and fairly fast urbanization. The development of technical infrastructure makes the urban amenities accessible also to the rural population and markedly affects its lifestyle. The principal difference against the cities lies in the lower level of education of the rural population and the ensuing consequences for the sectorial structure of employment, entrepreneurial drive, etc.

The primary industry presently employs only around one tenth of the rural population. A large part of the population residing in the South Moravian countryside commute for work to the urban areas and thus for them the countryside only retains its residential function. The tie to the land disappears but it was already seriously disrupted by the socialization of the countryside during the last regime and post-war population exchange on ethnic principles in the borderland rural regions.

Some functions of the countryside deriving from its role as the counterpart to the town in the social sense are equally threatened. It can be assumed that in future namely those functions will become preserved which stem from the small number of inhabitants of small rural settlements – social control, for example. Other functions that were previously tied to common work of the rural inhabitants in agriculture are getting lost. The South Moravian countryside however has a certain defence mechanism against the above-mentioned trends at its disposal. It is the surviving folklore connected with the culture of wine. Nowadays the male folk dance "verbuňk" forms part of the intangible world heritage of the UNESCO. The folk festivity called "Ride of Kings" applied in the same category. Viticulture is a typical example of an interlocking oof local products, their processing and local sale which asserts itself elsewhere in the Czech Republic only with great difficulties.

CONCLUSIONS: TRENDS AND REACTIONS

In near future it can be expected that the South Moravian countryside will witness the following trends:

- Continuing and gradually declining process of suburbanization and developing counter urbanization within the framework of amenity migration. Further increase in the share of inhabitants with a permanent rural residence not only in the hinterland of big cities but also selectively in some peripheral locations.
- Growing importance of leisure time, progressively more popular trends of learning and experience recreations. Specific population groups (hypothetically more educated members of the middle class) will be slowly turning away from purely relaxation or organized styles of recreation in the process of which they practically

do not come into touch with the local population and will incline towards individual recreation focused partly on learning about the concrete locations.

- Further declining share of the primary industries in the employment structure, development of other branches of industry and rural functions. Agriculture will still more incline towards the landscape maintenance position. On the other hand other land-intensive branches of industry which are less demanding on everyday contact with the customer will gain more ground in the rural space. Among them may well rank facilities producing renewable energy but also technical infrastructures, including waste dumps.
- Increasing significance of nature and landscape conservation. These activities will mainly concentrate on the rural space where they will provoke controversies regarding the economic use of space on the one hand but will raise attractiveness of the area on the other.
- Population ageing. The share of senior citizens in the rural space shall inevitably grow due to the current demographic trends and the departure of young and educated people to the cities. This opens up opportunities for developing a specific branch of services for senior citizens.
- Internationalization and globalization. The barrier effect of the state border will decline. The countryside may acquire significant financial aid from European projects and funds. Concrete development will, apart from other factors, depend on the share of the EU resources allocated for agricultural production and rural development.

The question of development or stagnation of the South Moravian countryside can be discussed in terms of its prerequisites for optimum responsiveness towards the aforesaid trends. The rural area of the Region is the hinterland of the largest and most important Moravian city of Brno which fully integrates this area at a regional level. At an inter-regional level the Region nevertheless includes several peripheral areas located by the national and land borders.

Natural conditions in the southern part of the South Moravian countryside are beneficial for the surviving agricultural production (but the lack of moisture may gradually prove to be a limiting factor). The South Moravian countryside as a whole is not very ecologically stable due to a high proportion of arable land. The South Moravian landscape, even in its southern lowland part, is not monotonous but undulating and dominated by the Pavlovské vrchy Hills above the Nové Mlýny water reservoirs. The fringe parts of this area are attractive for the development of recreation and tourism thanks to the height articulation of the relief, vegetation and cultural and historical sights. South Moravia is the only Czech territory with a thriving viticulture and folklore. It is a great example of interconnection of tourism and local products.

Rural settlements of above-average size (from national perspective) provide a sufficient internal market for the sustenance and development of at least an elementary level of services, they dispose of a big enough human potential for the preparation of development programmes and they usually have adequate budgets allowing for the allocation of subsidies. Neither Austrian nor Slovak border microregions provide a significant potential for a long-term economically beneficial collaboration. Viewed from the European perspective, it is unambiguously an inner periphery.

It needs be asked what the appropriate definition of progress or stagnation actually is. The experience of the last 50 years demonstrates that the perspective of progress shifts

from quantitative economic indicators towards quality criteria related to the social sphere. Although in the past 20 years capitalism lacking the social dimension has been trying to convert all values into the market and financial criteria, the turn to a better quality of life will outweigh it in the end.

The problem consists in the fact that the quality of life is hard to define. If we exaggerate a bit, we can say that the real quality of life is not related to the indicators used for its evaluation because the hard data are almost always in contradiction to human experience that also follows the patterns of individual age and of educational, cultural and other characteristics of the specific social groups. This leads us to the conclusion that different people may simultaneously perceive the South Moravian countryside as progressive and regressive. And this is the way it should be since the possibility of choice is the essence of a democratic society. It can be assumed that the South Moravian countryside offers such a choice.

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INTERNATIONAL SURVEY APPROACH FOR *PUCCINIA TRITICINA* OF WHEAT

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ABSTRACT – International Survey Approach for *Puccinina triticina* of Wheat
The main objective within new approach in international pathogenicity survey of *Puccinia triticina* was to provide genetically diverse sources of resistance (wheat lines with pyramiding resistant genes) to be used in a survey of wheat leaf rust pathogen in European-Mediterranean regions and to search for and document pathogenicity of *P. triticina* cultures useful in differentiating sources of resistance. Emphasis is placed on sources of resistance and their usefulness rather than on description of fungus populations.

Keywords: Puccinia triticina, wheat, International survey, hybrid lines.

INTRODUCTION

Leaf or brown rust caused by *Puccinia triticina* (*Puccinia recondita* Roberge ex Desmaz. f. sp. *tritici* Eriks. & E. Henn.) is probably the most important disease on the worldwide basis and yield losses may reach 40% in susceptible cultivars. Strategy for durability of leaf rust resistance in cultivars after the are released in agriculture is perhaps more important than achieving resistance in the first instance. The objective of cultivar management, regardless of epidemic probability, is to maximize the potential durability of deployed resistance. The global leaf rust population varies in virulence and this variation may result from one or more factors. The essential orientation for the international studies of the rust pathogens where their long distance dissemination as well established phenomenon. Wind is a great uncontrolled carrier of inoculum and urediospores of rust fungi are recognized as international travelers (ROELFS, 1985; BOŠKOVIĆ AND BOŠKOVIĆ JELENA, 2007). This was the mean reason why the best method of rust pathogen control was a network of international cooperative studies which would cover large epidemiological areas (BOŠKOVIĆ JELENA ET. AL., 2001; 2008A; MESTERHÁZY ET AL, 2000; GOYEAU ET AL, 2006; LI ET AL., 2010).

The importance and necessity of cooperative international investigations of the wheat rusts was especially emphasized by the European and Mediterranean Cereal Rusts Foundation. That was included first time in resolutions of Cereal Rust Conferences in Cambrige, 1964 and later on the others. Cooperative research of yellow rust of wheat for Europe had been organized in Netherlands, for stem rust in Portugal and Italy, and for leaf rust in Yugoslavia. The European Project of Wheat Leaf Rust Research had been started in Novi Sad dealing primarily with pathogenicity surveys of P. triticina in European-Mediterranean regions and breeding for resistance (BOŠKOVIĆ, 1966). From that time in International surveys for European-Mediterranean regions different sets of Lr lines have been used (BOŠKOVIĆ JELENA ET. AL., 2001). The same Lr lines used hadn't any value for European-Mediterranean regions. It was clear, even years ago, that these regions needed

new more efficient resistance genes and large testing and crossing program started in that time. At the beginning 18 donors of resistance had been selected after an extensive screening tests of several International rusts nurseries, for crossing with varieties Princ and Starke. Later on, eight of these hybrid lines with the most interesting donor, 66, 77, 26, 32, 46, 94 and 146, have been crossed with only effective genes Lr9, Lr19 and Lr24 (BOŠKOVIĆ JELENA ET AL., 2008B).

The main objective within new approach in international patogenicity survey of Puccinia triticina was to provide genetically diverse sources of resistance (wheat lines with pyramiding resistant genes) to be used in a survey of wheat leaf rust pathogen in European-Mediterranean regions and to search for and document pathogenicity of P. triticina cultures useful in differentiating sources of resistance. Emphasis is placed on sources of resistance and their usefulness rather than on description of fungus populations.

MATERIALS AND METHODS

The methods are applied according to the following approaches and procedure:
Central Field Nursery Each year in this field nursery numerous field materials from International rust nurseries as well as numerous breeding wheat lines from our program have been tested in the condition of artificial inoculations.
Central Seeding Test *P. triticina* collections from regional nurseries (ELRWN) have been sent to Novi Sad where has been cultured and there virulence to the source lines confirmed. When virulence to a given line is found and confirmed by greenhouse tests, that line should be removed from the field nursery and replaced by another line with potential value. This procedure is based on the concept of maximizing the number of sources of resistance to be studied. It is assumed that once virulent cultures are available, these cultures can be used to separate that line from other sources of resistance. Analysis of infection-type data has been done to distinguish between sources of resistance and to evaluate the usefulness of different sources of resistance in various places of the European-Mediterranean regions.

Cooperative Seeding Tests Uniform sets in European Leaf Rust Wheat Nursery (ELRWN) and possibly some other potentially useful sources of resistance, should be inoculated with several prevalent cultures by 6-8 cooperators in several countries well-disposed on European-Mediterranean territory.

Regional Field Nurseries (ELRWN) This approach should involvee testing of a uniform set of wheat lines to naturally occuring *P. triticina* populations at 20-30 sites in Europe and Mediterranean regions. The materials included should emphasize only wheat lines previously tested and shown to be highly resistant, and for which there is indication of diverse resistance genotype. Observations of leaf rust severity should be made by cooperators and sent to Novi Sad for assembling and summarization. The materials in these nurseries will also provide a basis for collecting uredial cultures which are virulent to some or all of the wheat lines. These cultures are used in further greenhouse and laboratory studies for differentation sources of resistance. The seedlings in the greenhouse where scored for infection type according to a scale 0-9 and variations were classified for easier computerization. Reaction classes (R, I and S) comprized the following variation of inffections types »R« - 1, 2, 3, 4, (0, 0; 1, 2) »I« – 5, 6, (X^-, X^+) and »S« - 7, 8, and 9 (3^-, 3^+, 4). Since the segregation was very frequent in the seedlings and in the field, that was designated by »,« For leaf rust and ather rusts the reactions are recorded by severity (0-99) and response (VR-S). In the field are recorded desease severity, the parentage of the

surface of the plant tillers and leavs affected, using the modified Cobb scale (PETERSON ET AL, 1984). Host response, the type of infections observed (R - resistant, I - all intermediate types and S – susceptible).

Severity is reduced to a single digit as follows: 0=0; 10=1; 11-25=2; 26-35=3; 36-45=4; 46-55=5; 56-65=6; 66-75=7; 76-85=8; 86-100=9. Host response is changed from R, I and S to 0-9 scale to computerization and deriving coefficient of infection. R= 0-3 or 2; I=4-6 or 5; S=7-9 or 8.

As a material have been used our hybrid lines with pyramiding resistant genes and other highly resistant wheat genotypes in ELRWN selected according to above explained procedures. In Central Field Nursery are included complete International Rust Nurseries and numerous of our breeding lines.

RESULTS AND DISCUSSION

In Central Field Nursery have been tested in the field eight International Rust Nurseries with total of 410 entries and seven spring wheat – CIMMYT Nurseries with 708 entries. In addition to Central Nursery have been tested hybrid progenies from the breeding program of accumulation, or pyramiding resistant genes. In breeding material were included 834 hybrid lines. Some selected of all these material have been tested in the greenhouse (seedling stage) to twenty-two international cultures of *P. triticina* from Regional Field Nurseries (ELRWN). Cooperative Seedling Tests in the second year included selected 36 winter and spring wheat entries in ELRWN. Seedling tests to particular pathotypes of *P. triticina* have been realized in the following countries: Germany (one pathotype), Czechoslovakia (two pathotypes), Sweden (one path.), China (three path.), France (four path.), Italy (two path.), Bulgaria (four path.) and Israel (five path.) – in total 22 pathotypes (Table 1).

A Regional Field Nursery (ELRWN) comprised in second year twenty of winter wheat hybrid lines with pyramiding resistant genes from our breeding program and sixteen highly resistant spring wheat lines, again selected from tested and analyzed International Wheat Rust Nurseries. Field ELRWN nurseries with 36 entries have been realized in 13 countries and evaluated to *P. triticina* and some other wheat pathogens: Germany (3 sites), Austria, Holland, Bulgaria, Israel, Sweden, Switzerland, Italy, Poland, Czechoslovakia, Spain, France and Chile.

All winter wheat hybrid lines with accumulation of resistant genes containing strong resistant genes Lr9, Lr 19 and Lr24 have shown very good results. But, there is a very slight difference between them in degree of resistance. The best were the lines NS-66/5×Lr24, NS-77/2×Lr19, NS-37/2×Lr19, then NS-66/2×Lr19, NS-77/3×Lr24, NS-66/4×Lr19, NS-26/2×Lr19, and NS-26/1×Lr9, NS-32/2×Lr19, NS-94/4×Lr19. These hybrid lines have had a little better combining ability from the genes of the donors and strong resistant genes Lr9, Lr19 and Lr24, which resulted, with some higher degree of resistance. Within spring wheat lines in ELRWN, the best results obtained were the lines 647-CMA-14793 and 26TH-ESWYT-10. Less resistance have had 26TH-ESWYT-36, 11TH-ESWYT-20 and 26TH-ESWYT-3. For these spring lines it can be supposed that they contain several resistant genes. Other spring lines have had insufficient resistance or quite susceptible reactions. The most typical were the lines Lr9, Lr19 and Lr24 which had been used in our breeding program for accumulation of resistant genes. It is clear that these lines loosed almost complete resistance as Lr9 and Lr24, but much less Lr19 (BOŠKOVIĆ JELENA AND BOŠKOVIĆ, 2009). It is important to compare these results of twenty wheat lines containing accumulated resistant genes with the same lines where have been reported

the segregation ratios of F_2 generations (BOŠKOVIĆ JELENA ET AL, 2001; 2008B). The number of resistant genes of these twenty lines in the table is very good correlated with results obtained in the seedlings and adult plants in ELRWN nurseries in Table 1.

Tab.1 – Seedling and field response in the second year ELRWN to *Puccinia triticina*

Winter wheat lines		Cooperative seedling tests			Field response	
		Reaction to 22 pathotypes of *P. triticina*			Reactions in 13 ELRWN	
		R	Seg.	S	R	S
1	NS-66/5×Lr24	22	-	-	13	-
2	NS-66/2×Lr9	21	1		13	-
3	NS77/2×Lr19	22	-	-	13	-
4	NS-77/3×Lr24	21	1	-	13	-
5	NS-26/1×Lr9	20	2	-	12	1
6	NS-32/2×Lr19	20	2	-	13	-
7	NS-37/2×Lr9	22	-	-	13	-
8	NS-66/4×Lr19	21	1	-	13	-
9	NS-26/2×Lr19	21	1	-	13	-
10	NS-26/2×Lr24	19	3	-	11	2
11	NS-32/1×Lr9	18	2	2	12	1
12	NS-32/3×Lr24	19	3	-	12	1
13	NS-46/2×Lr9	16	4	2	11	2
14	NS-46/3×Lr19	17	3	2	10	3
15	NS-46/3×Lr24	18	2	2	11	2
16	NS-94/2×Lr9	18	4	-	12	1
17	NS-94/4×Lr19	20	2	-	12	1
18	NS-94/5×Lr24	19	2	1	13	-
19	NS-146/1×Lr9	16	4	2	11	2
20	NS-146/3×Lr19	18	4	-	12	1
Spring wheat lines						
1	81-ND-582	14	1	7	10	3
2	417-ND-660	9	4	9	8	5
3	647-CMA-14793	22	-	-	12	1
4	11TH-ESWYT-20	18	4	-	8	5
5	11TH-ESWYT-25	15	5	2	10	3
6	11TH-ESWYT-30	6	7	9	7	6
7	26TH-ESWYT-3	18	2	2	10	3
8	26TH-ESWYT-10	22	-	-	12	1
9	26TH-ESWYT-36	21	1	-	10	3
10	26TH-ESWYT-49	12	6	4	8	5
11	26TH-ESWYT-50	12	3	7	9	4
12	Lr9	4	9	9	6	7
13	Lr18	2	5	15	5	8
14	Lr19	12	6	4	11	2
15	Lr24	6	2	14	8	5
16	Lr14	2	8	12	3	10

That means, correlation of degree of resistance of cooperative seedling tests to particularly pathotypes of *P. triticina*, as well as to degree of resistance in the field of the ELRWN in corresponding countries to the number of resistant genes in F_2 generations of each breeding combination (Table 2). Recently has been reported that pathogenicity studies of European populations of *Puccinia triticina* using pathogenicity and molecular markers resulted in 35 pathotypes identified from 68 isolates examined, all of which were avirulent for the genes

Lr9, Lr19 and Lr24, as well as to the other Lr's - Lr21, Lr25 an Lr29 (PARK ET AL, 1996; HYSING, 2007; ORDOÑEZ, AND KOLMER 2009).

Tab.2 – The segregation ratios in the F_2 generation of crosses between eight sources of resistance and Lr lines Lr9, Lr19 and Lr24 using three pathotypes of *Puccinia triticina.*

	Pathotype								
	B.g.s.1289			Is.w.889			Chl.w.1489		
Cross	Exp. Ratio	χ^2	P	Exp. Ratio	χ^2	P	Exp. Ratio	χ^2	P
NS-66/5×Lr24	57:7	0.35	0.55	57:7	0.53	0.48	54:7	0.16	0.82
NS-66/2×Lr9	57:7	0.24	0.62	9:7	0.15	0.70	45:19	0.77	0.37
NS77/2×Lr19	57:7	0.67	0.40	13:3	0.01	0.92	54:10	0.01	0.92
NS-77/3×Lr24	15:1	0.36	0.53	45:19	2.65	0.12	57:7	0.35	0.55
NS-26/1×Lr9	9:7	3.20	0.08	54:10	0.01	0.99	57:7	0.01	0.92
NS-32/2×Lr19	45:19	2.65	0.12	15:1	0.59	0.44	54:10	0.17	0.65
NS-37/2×Lr9	54:10	0.17	0.65	3:1	0.08	0.75	54:10	0.17	0.65
NS-66/4×Lr19	13:3	0.35	0.55	15:1	0.60	0.53	54:10	0.16	0.70
NS-26/2×Lr19	9:7	0.02	0.90	57:7	0.04	0.82	15:1	1.44	0.24
NS-26/2×Lr24	13:3	0.14	0.70	3:1	1.16	0.32	45:19	0.33	0.58
NS-32/1×Lr9	3:1	0.95	0.75	57:7	0.05	0.82	9:7	0.02	0.90
NS-32/3×Lr24	15:1	1.60	0.24	15:1	1.07	0.32	57:7	0.01	0.92
NS-46/2×Lr9	9:7	0.02	0.90	57:7	0.27	0.58	15:1	1.44	0.24
NS-46/3×Lr19	15:1	0.09	0.75	51:13	0.01	0.92	13:3	0.01	0.92
NS-46/3×Lr24	15:1	0.18	0.65	57:7	0.27	0.58	9:7	0.02	0.02
NS-94/2×Lr9	9:7	0.07	0.80	15:1	1.12	0.32	54:10	1.87	0.16
NS-94/4×Lr19	9:7	1.47	0.30	15:1	0.32	0.58	45:19	2.65	0.12
NS-94/5×Lr24	15:1	0.65	0.42	9:7	1.02	0.32	54:10	0.15	0.70
NS-146/1×Lr9	15:1	3.15	0.08	54:10	0.19	0.65	15:1	0.82	0.27
NS-146/3×Lr19	15:1	0.18	0.94	45:19	0.01	0.92	15:1	1.60	0.24

CONCLUSIONS

It is well known in the last time that combining or pyramiding of resistance genes into individual cultivars has had considerable success in reducing the rate of evolution of pathogens particularly in the situations where the pathogen does not reproduce sexually, as in the case of *P. triticina.* Considerable arguments for durability of cultivars with pyramided race-specific resistance genes have been already reported Samedifferences in F2 generation concerning the number of resistance genes related to particular pathotypes of *P. triticina* was already reported by other authors stating that differences can depend from different donors and pathotypes used.

In the time when we used the lines with strong genes Lr9, Lr19 and Lr24 in our breeding program that lines have had very high resistance on the large epidemiological territory, meanwhile, these lines loosed almost complete resistance, as Lr9 and Lr24 and much less Lr19.

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A CSERESZNYE *(Prunus avium L.)* REPEDÉSRE VALÓ HAJLAMÁNAK VIZSGÁLATA MAGYARORSZÁGON 2009-BEN

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ABSTRACT – Crack of sweet cherries in 2009
The spring aridity was considerable in 2009 during the development of the sweet cherry's fruit there wasn't precipitation, but there was suddenly a great amount of rain during fruit ripening. The 25-30 mm precipitation in May and the 70-80 mm precipitation in June has caused extensive in cracking in the medium and late sweet cherry cultivars. According to our survey the degree of cracking varied at the different species the crisp sweet cherries were more likely to crack then the species soft peal. As our result of survey it is clear that the degree of the cracking in the 'Paulus' cultivar was extensive it was the same in the case of 'Linda' cultivar , but the 'Katalin' and' Sunburs' didn't crack as much as the 'Paulus' vultivar did. So the varieties most susceptible to cracking include 'Germersdorfi óriás', 'Katalin', 'Paulus', 'Sweet Hart', 'Alex', 'Regina'. Low susceptibility varieties include 'Hedelfingeni óriás', 'Solymári gömbölyű'.

Keywords: *Cerasus avium*, sweet cherry, fruit crack, drought, precipitation

BEVEZETÉS

Számos országban, így Magyarországon is súlyos problémát jelent a gyümölcsrepedés a cseresznyénél. A cseresznyerepedést az éréshez közeli időben kapott nagy mennyiségű csapadék is okozhatja. A gyümölcs repedését főleg akkor tapasztalhatjuk az ültetvényben, ha a gyümölcs növekedése idején kevés volt a csapadék, mérsékelt volt az öntözés, de az érés során nagy mennyiségű csapadékot kapott a gyümölcsös. A hőmérséklet is hatással lehet a repedés mértékére, ha hűvös, csapadékos időjárás köszönt be a cseresznyeérés idején, sokkal nagyobb mértékű a repedés, mintha meleg időjárás lenne, hiszen ekkor gyorsan felszárad a gyümölcs héja, és nem tud a gyümölcsbe áramlani a víz.

Tanulmányunkban a cseresznye repedését vizsgáltuk 2009-ben Kecskemét, Gerő – majorban és Nagykutason.

Korábbi szakirodalmakban azt olvashattuk, hogy a gyökéren keresztül felszívott nagy mennyiségű víz okozza a repedést. Ma már tudjuk, hogy a gyümölcs felületén beáramló víz jelenti a nagyobb gondot. A gyümölcs felületén jelenlévő víz, és a gyümölcshús cukor töménységének koncentráció különbsége révén ozmózis jelensége jön létre, így a víz beáramlik a gyümölcs héján keresztül a gyümölcshúsba (SIMON 2003), amely főleg a ropogós cseresznyéknél okoz gondot, a szívcseresznyéknél nem, vagy kevésbé.

A cseresznye mérsékelt vízigényű gyümölcsfaj, 500-600 mm csapadékigényével akár öntözés nélkül is termeszthető. De az intenzív ültetvényekben a nagy terméshozamok elérése, és a repedés elleni védekezés miatt érdemes öntözéssel 800-900 mm-re kiegészíteni a vízmennyiséget (SIMON 2004).

A Michigeni Kutató Intézet fajtaajánlásai alapján elmondható, hogy a 'Cavalier', 'Viva', 'Valera', 'Kristin', 'Royalton', 'Sweetheart' mérsékelten ellenáll a repedésnek, a 'Sam', 'Nelson', 'Schmidt', 'Hedelfingen' 'Regina', 'Hudson' jó, vagy nagyon jó az ellenálló-képessége a repedéssel szemben (NUGET 1999).

Cross (2009) szerint a 'Bing', és a 'Black Tartarian' szívcseresznyék, az 'Emperor Francis 'ellenállóbbak a repedéssel szemben, mint a 'Napoleon'. A 'Hedelfingen' fajtának a repedéssel szembeni ellenálló-képessége jó. Andris (2003) véleménye szerint a 'Bing', 'Lambert', 'Early Burlat ' fajták igen érzékenyek a repedésre. Mérsékelt a repedési

hajlama a 'Van', 'Stella', 'Vega ' fajtáknak. És igen gyenge repedési hajlamot mutat a 'Sam', 'Vista', 'Viva','Schmidt', 'Emperor Francis' fajta.

A repedés ellen hatásos lehet a réz-hidroxid és a kalcium-hidroxid. Ezekkel a szerekkel kell repedés előtt bepermetezni a fákat és lényegesen kevesebb repedt gyümölcs lesz a fákon. A fővirágzás után 3.-6. héten kell elvégezni a permetezést (BROWN ET AL., 1994).

ANYAG ÉS MÓDSZER

Kecskeméten Gerő-majorban és Nagykutason végeztük a vizsgálatainkat. Gyümölcsérés idején a repedt gyümölcsöket figyeltük meg, hogy a repedés elsősorban az érett vagy az éretlen gyümölcsön jelentkezik-e, és hogy a gyümölcs felületén milyen mértékben, és hol található a repedés. Június 3. –a és június 26.-a között vizsgáltuk a gyümölcsök repedését.

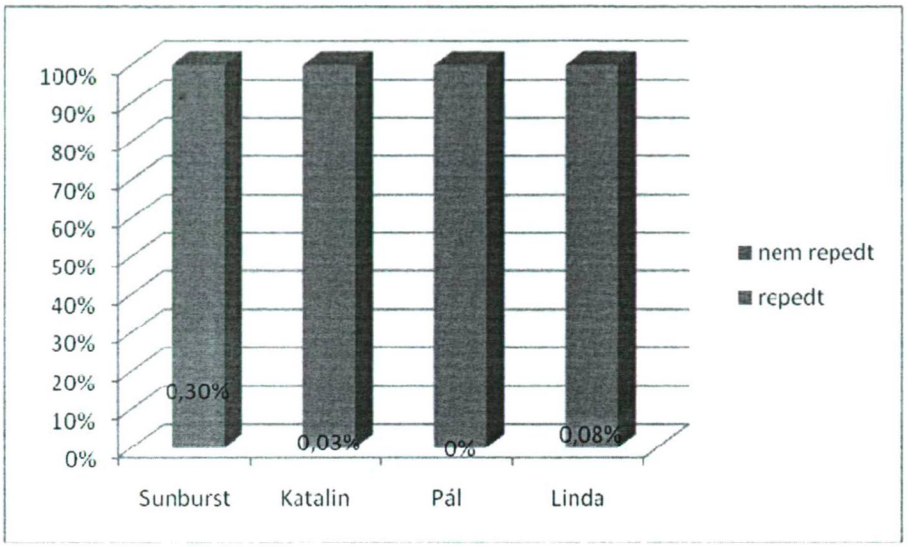
A gyümölcsfejlődés idején öntözéssel kijuttatott víz mennyisége 3 x 20 mm volt. A hirtelen, érés időben lehullott csapadék mennyisége 40 mm volt. A cseresznyés talaja vályogtalaj. A vizsgált időszakban nem használtunk sem réz-hidroxid, sem kalcium-hidroxid készítményeket. A repedések mértékét vizuális növénydiagnózissal mértük fel, eredményeket statisztikai módszerekkel értékeltük ki.

EREDMÉNYEK

Az eredmények során megállapíthatjuk, hogy éretlen állapotban kevésbé repedtek a gyümölcsök, a nagy mennyiségű csapadék hatására. Kiemelkedő repedést a 'Sunburst' fajtánál tapasztaltunk már az éretlen gyümölcsökön is (1 ábra). Irodalmi adatok és a saját tapasztalataink alapján elmondható, hogy az alábbi cseresznye fajtáknál különböző repedést tapasztalhatunk (1. táblázat).

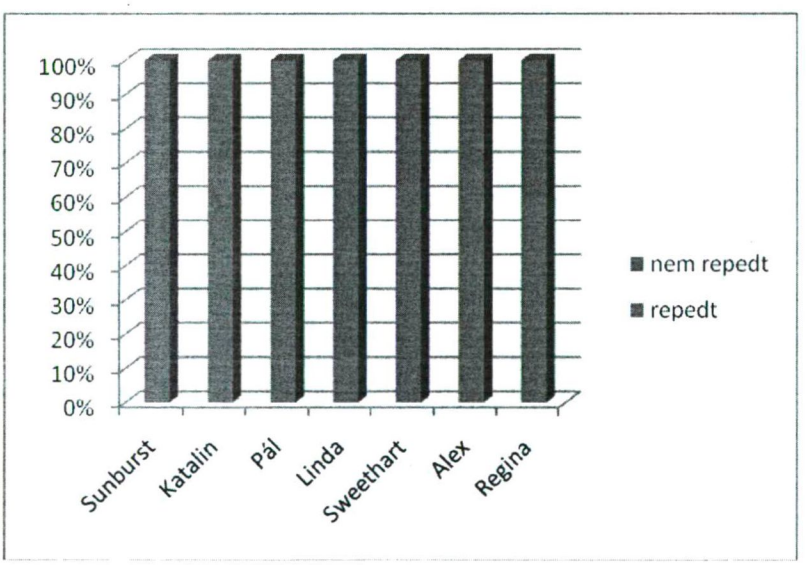
1. táblázat Az általunk vizsgált cseresznye fajták jellemzése

Repedésre hajlamos ropogóscseresznye fajták	**Repedésre kevésbé hajlamos fajták**	**Repedésre nem hajlamos szívcseresznye fajták**
Germersdorfi óriás, Katalin, Pál, Sweet Heart, Axel, Regina.	Szomolyai fekete, Van.	Hedelfingeni óriás, Solymári gömbölyű.



1. ábra: Az éretlen cseresznye repedési aránya

Az érett gyümölcsöknél sokkal nagyobb mértékű repedés volt, mint az éretlennél. Kiemelkedő repedést tapasztalhattunk, a 'Pál' és a 'Katalin' fajtáknál, de szintén nagy arányban repedtek a gyümölcsei a 'Sunburst', a 'Sweet Heart' az 'Alex' és a 'Regina' fajtának. Legkevésbé a 'Linda' gyümölcsei repedtek a vizsgált fajták közül.



2. ábra: Az érett cseresznye repedési aránya

A Nagykutason termesztett fajták repedésre való hajlama látható az alábbi (2.) táblázatban.

2. táblázat A cseresznyefajták termésein tapasztalt repedések mértéke

Fajta	Repedt gyümölcsök aránya(%)
'Techlovom'	76%
'Sanda Ross'	61%
'Canada Giant'	54%
'Katalin'	45%
'Alex'	44%
'Sweat Heart'	44%
'Giant Red'.	40%
'Regina'	39%
'Cristalina'	37%
'Skeena'	34%
'Symphony'	29%
'Germersdorfi Riple'	19%
'Chelon'	18%

3. táblázat Az összes repedést megvizsgálva a repedés helye, típusa és hatása alapján a gyümölcsök megoszlása a következő volt:

Repedés helye és típusa	%
kocsánynál körkörös repedés	26,0
repedés nyomán rothadt gyümölcsök	23,8
bibepontnál kismértékű repedés	16,8
bibepontnál nagymértékű repedés	12,6
többirányú repedés a gyümölcs középső részén	9,7
keresztirányú repedés a gyümölcs középső részén	6,1
hosszirányú repedés a gyümölcs középső részén	5,0

KÖVETKEZTETÉSEK

Adataink bizonyítják, hogy mindegyik cseresznyefajta érzékeny a repedésre, ha éréskor eső éri. A fajták között viszont jelentős eltérés lehet a repedési hajlamban, helyében, típusában. A repedés mértékét és jellegét a fajtatulajdonságok (gyümölcs héj rugalmassága, gyümölcs alakja, szárazanyag-tartalma, turgornyomása, a fa vízszállítása), a környezeti tényezők és technológiai körülmények együttesen határozzák meg.

A cseresznye fajták megválasztásánál, nem elegendő csak a külföldi irodalmakra támaszkodni, meg kell vizsgálni a fajtákat hazai körülmények között is, mert eltérő termesztő területeken a külföldi adatoktól eltérő eredményeket is kaphatunk.

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WHOLE BARLEY-DILUTED DIETS IN BROILERS AND ITS ECONOMY

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ABSTRACT- Whole barley-diluted diets in broilers and its economy
This study was conducted to determine the effect of semi-choice or free-choice feeding using whole barley supplemented diets with a commerical enzyme preparation in broiler chickens. Male broiler chicks were divided into four experimental groups at 19 days of age. The control birds fed a standard mash grower diet. Two groups were fed the standard mash grower diet with whole barley from 19 to 42 days using a training period (semi-choice I) or directly from 24 to 42 days of age (semi-choice II). Remaining one group was fed separately both of the standard grower diet and whole barley within two feeders. Body weight gains were not affected ($P>0.05$) by the treatments. Free-choice-fed broilers consumed more total food and selected whole barley than the others ($P<0.05$). However, gain: feed ratio was lower in free-choice-fed broilers compared to control ($P<0.05$). Broilers given whole barley which mixed with grower diet or free-choice-fed selected less energy and protein in their diets than those fed control ($P<0.05$). Free-choice-fed broilers were also deposited more abdominal fat compared to the control. Whole barley caused an increase in gizzard size. Feed costs per kg of body weight gain were decreased by using whole barley.

Keywords: broilers, whole barley, choice-feeding, costs

INTRODUCTION

Many years ago, feeding chickens with whole cereals was a traditional feeding regimen. However, with the increase of intensive poultry production, poultry producers began to use full-feed mash or pelleted diets. In recent years, there has been an interest on feeding broilers with whole cereals. Thus, the use of whole cereals in diets for poultry has become common place in many countries to decrease feed costs and to increase performance (BANFIELD and FORBES, 2001; BENNETT et al., 2002; KWIECIEN and WINIARSKA-MIECZAN., 2010). Moreover, the use of whole cerals in pelleted or crumbled broiler feeds is a new feed processing method for reducing feed production cost in some European countries. Because of high proportion of corn, whole wheat and whole barley in broiler diets can become more economic (NAHAS and LEFRANCOIS, 2001). Whole cereals have some additional advantages other than ecocomy such as increased gizzard size and performance and decreased coccidiosis risk in practice (BENNET et al., 2002; SHIVUS et al., 2004). Physical form of foods have affect on gizzard development (MUNT et al., 1995). Due to the gizzard development, whole grains increase the ability of birds to grind food, ease digestion and consequently the energy and amino acids may be utilized more efficiently (SHIVUS et al., 1997a).

In broiler production, dietS which is formulated to meet the requirements of the average bird will have inadequate levels of main nutrients such as energy and protein for broilers or above the mean. Broilers have ability to select a well-balanced diet when feeds offered as free-choice or semi-choice (POUSGA et al.,2005). Birds' age are important in the learning process. The optimum age for imprinting to grains is the second week after hatching (FORBES and COVASA, 1995). Broilers will select a diet close to optimal for growth if diet offers free-choice (COVASA and FORBES, 1993b; FORBES and SHARIATMADARI, 1994b). Wheat is known as the main foods for people in many developing countries, but barley is essentially known as an animal feed. Therefore, whole barley supplemented with exagenous enzymes can be prefer to whole wheat in many

countries. The antinutritional effect of beta glucans on broiler chicks is the main problem with barley. Many researchers previously indicated that beta glucans depress broiler growth and cause wet droppings. Adding beta glucanes to broiler diets given broilers can eliminate the wet dropping and gummy dropping problems by increase in digestion and absorbtion of nutrients in gut of broilers (KWIECIEN and WINIARSKA-MIECZAN, 2010). Many researchers (SHIVUS et al., 2004; RAVINDRAN et al.,2006; AMERAH and RAVINDRAN, 2008) previously reported the effects of whole wheat on broiler performance in some feeding regimens. However, using whole barley in broiler diets mainly based on feeding broilers feed hulless barley (ANDERSON and MACISAAC 2001; KWIECIEN and WINIARSKA-MIECZAN., 2010).

Use of whole barley in these feeding regimen may cause a decrease in feed costs consumed by broiler chickens because of lower price of whole cereals compared to mashed feed and decreased costs of grinding. The objectives of this experiment were to examine effects of semi-choice or free-choice feeding regimens of diluted diets with whole barley supplemented with exagenous enzymes on performance and feed costs in broiler chickens.

MATERIAL AND METHOD

In this experiement, broiler chiks obtained from a commercial hatchery and fed together in a littered flor pen and fed *ad libitum* with a standard commercial broiler starter diet. At 19 days of age, a total of 204 male broiler chicks were individually weighed and divided into four experimental groups and exposed to one of four feeding treatments with three replicates per treatment and 17 birds per pen. Broilers kept in a littered floor pens with hanged feeders and drinkers. A 24 hours lightining program was applied throughout the experimental period. The temperature and humidity were arranged by automatically. The contents of standard grower diet given control birds from 19 to 42 days of age were illustrated in Table 1. Grower diet was mixed with 5, 10, 20 and 30% of whole barley containing 11.02% crude protein and 2650 kcal ME /kg, from 19 to 23 days, 24 to 28 days, 29 to 36 days and 36 to 42 days of age, respectively (semi-choice I). Other group of broilers were fed an undiluted grower diet from 19 to 24 days of age. After 24 days of age, they were given a diluted grower diet with 20% whole barley (semi-choice II). Remaining group was fed separately both grower diet and whole barley within two feeders from 19 to 42 days of age (free-choice). Diets containing whole barley were supplemented with a commercial enzyme preparations (2g/kg of total diet). Body weight gain and feed intake were determined at 24 , 28, 35 and 42 days of age. Three birds per replicate were slaughtered at 42 days of age to observe the effect of whole barley on abdominal fat and gizzard. Decrease in feed costs (%) per kg body weight gain compared to control were also calculated. Data were subjected to analysis of variance and significance of differences in means of treatments were compared to according to the procedure of Duncan.

Table 1: The composition of Standard grower diet (%)

Contents basal mash diet	%
Corn	50.15
Wheat	8.00
Soybean meal (44%)	26.00
Fullfat soybean	9.00
Meat-bone meal	1.50
Fish meal	1.00
Soybean oil	3.00
Limestone	0.39
Dicalcium phosphate	0.21
Sodium chloride	0.35
Vitamin premix	0.20
Mineral premix	0.10
Antioxdant	0.10
Metabolisable energy, kcal/kg	3100
Crude protein	21.00
Lysine	1.33
Methionine+cystine	0.92
Calcium	0.94
Available phosphorus	0.44

RESULTS

Effects of whole barley in broiler nutrition are illustrated in Table 2. Body weight gains of broilers were not affected by the feeding treatments. However, total feed (mash feed, barley or mash feed+barley) and whole barley intakes of birds fed free-choice basis were significantly higher ($P<0.05$) than other groups. Gain: feed ratio from 19 to 42 days of age was the highest in control birds ($P<0.05$) compared to free-choice group. Semi-choice groups had medium parameters between control and free choice group in gain:feed ratio.

The relative weight of abdominal fat was increased ($P<0.05$) by the free-choice feeding compared to the control, and tended to increase by feeding semi-choice. The relative weight of gizzard was bigger ($P<0.05$) in groups consumed whole barley than control. However, the biggest gizzards measured in semi-choice I broilers.

Althought the total protein intake of birds were not differed by the feeding strategies, the total energy intakes in free-choice group was higher ($P<0.05$) than control. When mash feed and whole barley supplied by free-choice, the selected diets by the broilers had lower ($P<0.05$) energy levels compared to control. The same results were also determined in selected protein levels and energy: protein ratio.

Feeding strategies depend on semi-choice and free-choice basis using whole barley decreased feed costs per kg of body weight gain between 1.84% and 5.62%. The free-choice feeding strategy with whole barley had an additional income in broiler production.

Table 2: Effects of experimental diets on total feed intake, growth performance (g/bird), whole barley intake (% of total feed intake), relative weight (g/100 g body weight) of abdominal fat and gizzard, intake of energy and protein, and decrease in feed costs(%)

	Diets and feeding regimens				
Parameters	Control	Semi-choice-I	Semi-choice-II	Free-choice	SEM
Initial BW	528.1	528.5	529.3	529.9	0.97
Body weight gain					
19 to 41 d	1790.7	1730.6	1767.9	1834.3	22.44
24 to 42 d	1497.9	1443.3	1482.2	1533.9	22.65
Total feed intake					
19 to 41 d	3677.0^{b}	3899.3^{b}	3829.1^{b}	4221.4^{a}	69.40
24 to 42 d	3139.7^{b}	3376.6^{ab}	3320.9^{b}	3676.1^{a}	67.6
Whole barley intake					
19 to 41 d	-	20.77^{b}	18.89^{b}	31.15^{a}	1.90
24 to 42 d	-	23.20^{b}	21.78^{b}	34.82^{a}	2.06
Gain : Feed					
19 to 41 d	0.488^{a}	0.443^{ab}	0.461^{ab}	0.434^{b}	0.008
24 to 42 d	0.479^{a}	0.427^{b}	0.446^{ab}	0.417^{a}	0.01
Relative weight of					
Abdominal fat	1.51^{b}	2.18^{ab}	2.03^{ab}	2.49^{a}	0.13
Gizzard	1.62^{c}	2.54^{a}	2.31^{ab}	2.14^{a}	0.09
Total energy intake (Mcal ME/bird)	11.39^{b}	11.72^{ab}	11.54^{ab}	12.49^{a}	0.17
Total protein intake (g/bird)	772.0	738.0	732.0	755.0	9.0
In selected diets					
ME,kcal/kg	3100^{a}	3006.5^{ab}	3014.9^{ab}	2959.8^{b}	41.30
Crude protein,%	21.00^{a}	18.92^{b}	19.11^{b}	17.88^{c}	0.21
Energy:Protein ratio	147.6^{b}	158.9^{ab}	157.7^{ab}	165.5^{a}	2.04
Decrease in feed costs per kg of body weight gain compared to control	-	1.84	4.64	5.62	-

^{a,b,c} Means with different supercript letters differ significantly ($P<0.05$)

CONCLUSIONS

In this experiment, broilers offered whole barley as free-choice consumed more mash feed and whole barley without affecting body weight gains. Increase in total feed intake mainly comes from increasing barley consumption and its lower energy level. Because energy deficiency in broiler diets could have created a high appetite. Increased abdominal fat deposition with whole barley consumption in semi-choice or free-choice fed broilers than control birds may also due to the higher total energy intakes. However, increased gizzard size was also a factor of increased feed intake. DEATON et al. (1977) and SHIVUS et al.(1997a) have indicated that diets containing high cellulose increased the sizes of crop and gizzard. Although the relative levels of crop was not determined in this study, the relative weight of gizzard in broilers fed whole barley was high than control birds. In contrast to the present experiment, NAHAS and FRANCOIS (2001) have reported

that increasing levels of whole barley caused a decrease in final body weight and gizzard weight. BENNETT et al. (2002) have found a decrease in body weight and important increase in gizzard size by feeding whole barley changed from 5% to 65%. The similar results on body weight gain with whole barley have determined by the KWIECIEN and WINIARSKA-MIECZAN. (2010). They also measured a decrease in breast meat weight.

Gain: feed ratio in free-choice fed broilers were also lower than control birds. It can be explained by the effect of high whole barley intake, its antinutritional contents and negative effects of them on digestion and body weight gain. SHIVUS et al. (2004) have indicated that the lack of improvement in gain: feed with whole wheat explained the higher energy expenditure on feeding and digestive activity fort he whole wheat diet. It is known that the heteregeneous feeds may increase amount of pecks on feed and thus energy spent on feeding. MARTARESCHE et al. (2000) determined that the pecking rate incresed with a cylindirical form of feeds. BENNETT et al. (2002) repeorted an negative effect of whole cereals on gain:feed , but an improvement in birds' health. ANDERSON and MACISAAC (2001) fed broilers with hulless barley and found a decrease in 36 days body weight and decrease in gain:feed. They suggested that broiler diets can be diluted with whole hulless barley up to a level of 15%. Free-choice fed broilers were also consumed more total energ without changing total protein intake by increased total feed intake. However, the energy and protein levels in selected diets by free-choice broilers were lower than control birds. Semi-choice fed broilers with whole barley diluted diets had lower energ levels in their selected diets. Despite of the increased feed intakes without affecting the body weight gain, an important decrease in energy and protein levels in selected diets by free-choice or semi-choice fed broilers also decreased feed costs per kg body weight gains up to 5.62%. decrease in feed costs could related to the cost of whole barley.

In conclusion, whole barley with exagenous enzyme can offer to broilers in semi-choice or free-choice feeding strategies by the broiler producers. The higher levels of whole barley decrease gain: feed ratio. However the energy and protein levels in standard broiler grower and finisher diets can be decreased by this feeding regimens. Thus, the diluted diets with whole barley will decrease in production costs.

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BREEDING OF NEW WHEAT VARIETIES WITH „PANNON" BREAD MAKING QUALITY IN SZEGED

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ABSTRACT – Breeding of new wheat varieties with „Pannon" Bread making Quality in Szeged
At the Cereal Research Non-Profit Ltd (CR) and at its progenitors breeding for high quality or improver quality wheat has a long history.
In our breeding programs selection for high quality does not separate from the main goals of the mainstream of general variety production: High bread-making quality must attached to appropriate yielding capacity, and stability of yield.
Breeding activity basically runs by traditional methods (Pedigree-method) and a new variety can be produced during a ten to fifteen years period if we take in account the three years evaluation of the registration procedure.
The quality of the exported wheat shall satisfy primarily demand of the targeted foreign market. The demand for quality of foreign markets needs to apply in the quality tests in the home market and in the breeding process of wheat, because of the big part of Hungarian wheat production exported to West-European markets. "Pannon project" was started to satisfy better the quality parameters in the export of wheat, it acted on the wheat breeding at Szeged too, this study deals with it.
The main effects of the Pannon Project on the production of new wheat varieties with high flour quality:
During the selection procedure for flour quality besides the conventional quality tests (gluten content, farinograph value, loaf volume) we evaluated the grain hardness, Zeleny-value, the developing time and stability of dough, falling number, alveographic and extensographic parameters too. By applying these tests we found many wheat lines which has good characteristics according to one or more quality traits, and the same time had high yield capacity and their agronomic characteristics are also suitable.
Pannon project affected and still affects the breeding materials by means of the selection: hopefully the number of the genotypes which fit the Pannon requirements will increase in our breeding material. The other advantageous effect is, that we take in consideration the pannon requirements when choosing the crossing partners for starting new combinations.
Keywords: winter wheat, breeding, bread-making quality, „pannon quality criteria"

PREFACE

Breeding high or improving quality wheat has a long history at the Cereal Research Non-Profit Co. and its (MATUZ, KERTÉSZ 2001). For example: the maintenance of the world-famous Bánkúti 1201 wheat cultivar (Szülő Ferenc, Bacsa Pál) continued until the beginning of the 1970-ties. János Lelley and László Parádi produced the excellent quality winter wheat variety GK Tiszatáj here, which was the only quality standard in the state trials for decades. From the beginning of the 1980ties, from Szeged such highly productive and good quality varieties completed like GK Öthalom, GK István, GK Barna, GK Véka, GK Pinka, GK Csörnöc, GK Kalász, GK Élet, GK Miska, GK Petur, GK Ati, GK Tisza, GK Békés.

Excellent bread making quality always was a fundamental goal of breeding even during the "quantity era". The prove of this approach is the breeding of GK Tiszatáj and GK Öthalom. The three essential goals of the Szeged breeding program from 1975 which were set are: increasing the yield capacity, maintaining, or improving the technological quality, and increasing the safety of the yield.

The quality of exported wheat first of all must fit the demands of the export market. Since Hungarian wheat export predominantly tends to west-European markets it is practical to include all their quality characters to our quality tests and our breeding

procedure. By organizations which interested in wheat growing, marketing and utilizing, the Pannon program was initiated for the better gratification of the special quality parameters in wheat export. Of course, Pannon program had a significant effect on Szeged breeding program. The Szeged trials and results of „Pannon program" itself was reviewed earlier (MATUZ ET AL. 2008, ÁCS ET AL. 2008, PETRÓCZI, ÁCS 2008, MATUZ, ÁCS 2008).

MATERIALS AND METHODS

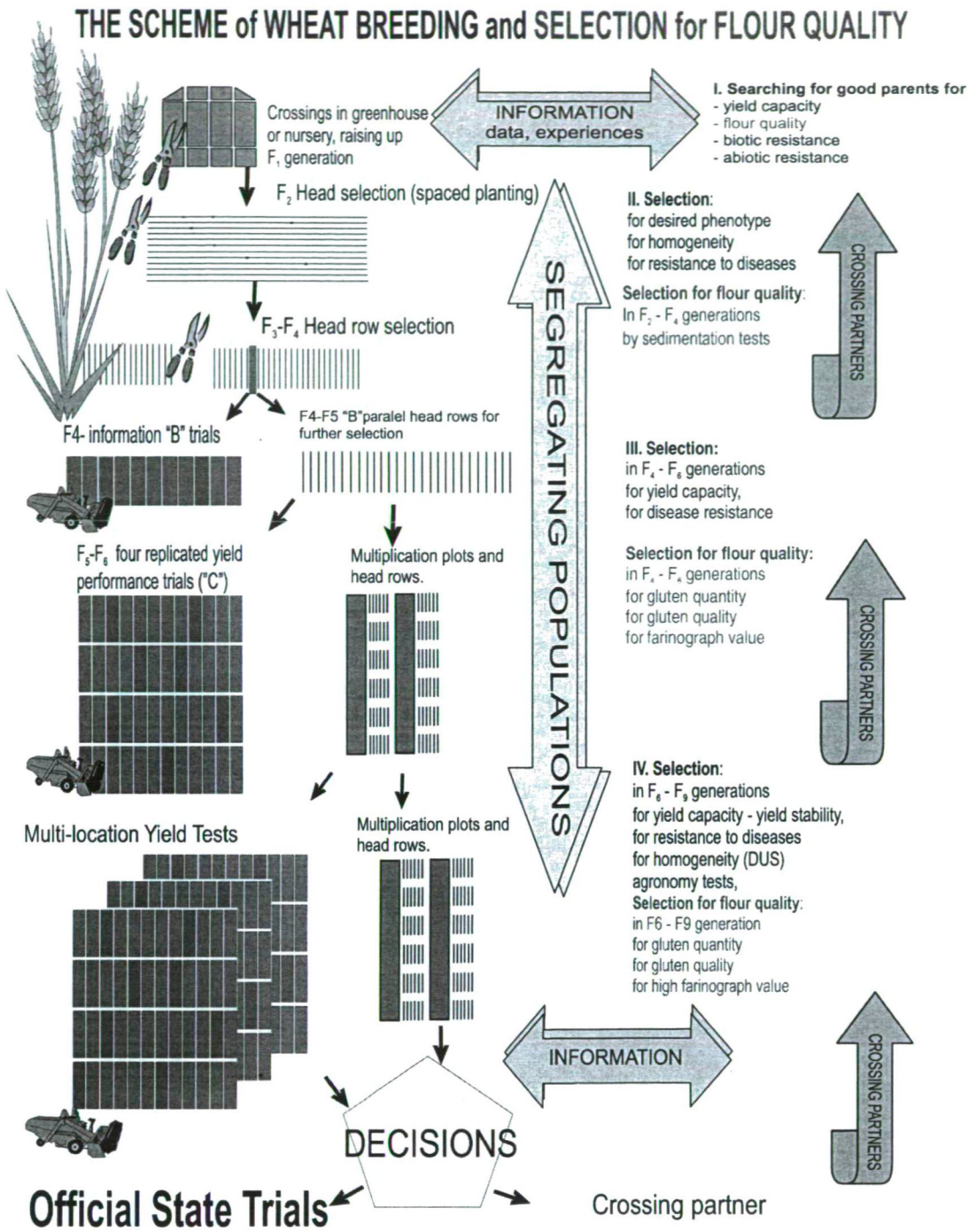
Pannon quality standard considers more quality characters than the Hungarian quality standard. Therefore we must include farinograph water absorption, developing time of dough, stability of dough, alveograph "W" and "P/L" values and extensograph measurements as selection criteria for breeding new varieties with Pannon quality.

Table 1* Pannon *Quality Criteria

Quality tests	Pannon quality		Hungarian standard	
	Premium Category	Standard Category	Extra Quality	Milling I.
Test weight (kg/hl)	80.0	78.0	78	76
Wheat raw protein content min. (%)	14.0	12.5	12,5	12,5
Wheat raw protein content on dry matter basis min. (%)	16.0	14.5		
Moisture content max. (%)	13.5	13.5	14,5	14,5
Falling number min. (sec)	300.0	250.0	300.0	250.0
Grain hardness HI, min. (%)	60.0	50.0		
Grain composition				
Ash content (%)	0.5	0.5		
Flour raw protein content min. (%)	13.0	11.5		
Quantity of wet gluten min. (m/m %)	34.0	30.0	34.0	30.0
Flour Zeleny sedimentation value (ml)	50.0	40.0	35	35
Rheological properties				
Farinograph values			A1	B1
- Water absorption (on 14% moisture basis), min. (%)	60.0	55.0		
- Dough development time max. (min)	4.0	6.0		
- Dough stability time min. (min)	10.0	6.0		
Alveograph values				
- W min. (*10-4 joules)	280	220		
- P/L max.	1.0	1.5		
Extensograph value				
- Energy, 135 min proving time, min. (cm^2)	120.0	75,0		

At the CRC in Szeged, wheat breeding is going on by conventional methods and the production of a new cultivar takes about 10-15 years included the three years' evaluation in the Official Field Trials (*Fig. 1.*). In our program selection for high flour quality is not separated to the general aims of variety production: high or even excellent quality must be attached to a proper productivity and safety of the yield. For the sake of achieving of this goal, selection is repeated in every generation for high yields, flour quality and resistance to different diseases as shown on figure 1. (KERTÉSZ ET AL. 1997, KERTÉSZ, MATUZ 2006). We had to adopt to this process new selection procedures for the new quality characteristics which are recommended by „Pannon" program.

Figure 1.



RESULTS

Due to the Pannon program the next changes happened in our breeding procedure for high flour quality wheat varieties:

The number of quality evaluation methods increased

From the above-mentioned breeding procedure the next quality tests help us to search for the highest quality genotypes:

At early generations, segregating populations (F2-F4, heads and yields of "A"-lines):

Visual evaluation of grains (healthiness, color, form, plumpness), **grain hardness** (PERTEN SKCS 4100), **by NIR or NIT equipments, gluten and protein content, Zeleny test** (MSZ ISO 5529).

At „B", C and advanced lines (F5-F∞):

For fast screening we use the same tests than at the early generations,

Flour yield % (Brabender Senior mill), wet gluten content %, dry gluten content %, gluten elasticity (mm) (MSZ 6367/12-87),

Farinograph characters: the water absorption capacity of flour, **developing time and stability of dough,** Farinograph value

Baking test: loaf volume, loaf form coefficient, area of loaf segment

Falling number (ISO 3093:2009), alveograph test (ISO 5530-4), extensograph test (ISO 5530-2).

Screening quality tests with bold letters take part (or will take part) of our breeding system according to the recommendations of Pannon project. By using these evaluations in different screening and performance trials we could select many breeding lines with good performance in one or more quality characters, in addition to high yield capacity and adequate agronomic parameters appropriate for a modern wheat cultivar.

The results of the 2009 breeding material's evaluations:

- Among the tested variety candidates only one proved to be appropriate for all the 7 "Pannon" characters (protein content, falling number, grain hardness, wet gluten, Zeleny-value, farinograph water absorption, stability), 4 candidates did 6, and 3 candidates did 5 characters.
- Among the 28 advanced lines 5 hit "Pannon" level in all the 7 characters, 14 in 6 characters and 5 in five characters. 3 more lines in four characters and one line in three characters fit the demands.
- In 2009 113 more winter wheat lines were tested for 5 "Pannon" quality characters (protein content, falling number, grain hardness, wet gluten and Zeleny-value) and 35 samples fit the criteria of the quality demands. At 16 more lines 4 characters, at 47 lines 3, at 12 lines 2 and in case of two lines only 1 quality character could reach the limit values of Pannon standard.

Selection work and its efficiency highly depend on the year effect and weather conditions. For instance we have a long selection project for kernel hardiness and for this purpose hundreds of lines were evaluated and all the soft types were discarded. According to the four years' data, the distribution of the wheat lines according to the grain hardness significantly does not change (Fig. 2). Between 2006 and 2008 generally the proportion of the hard grain lines increased, but in 2009 significant recurrence detected in this case. This consequence is happened due to the weather changes and because of the emergence of the numerous new breeding lines which haven't been selected for this trait yet. The data of the two control varieties shows the effect of the different years (Fig. 3.). The width of the distribution curves indicates that we have the possibility for select for extra hard and extra soft grains as well. On the other hand, control varieties show, that in spite of the important year effects varieties quite well retain their grain's hardness.

Figure 2.The distribution curves of the grain hardness of wheat lines in Szeged between 2006 and 2009

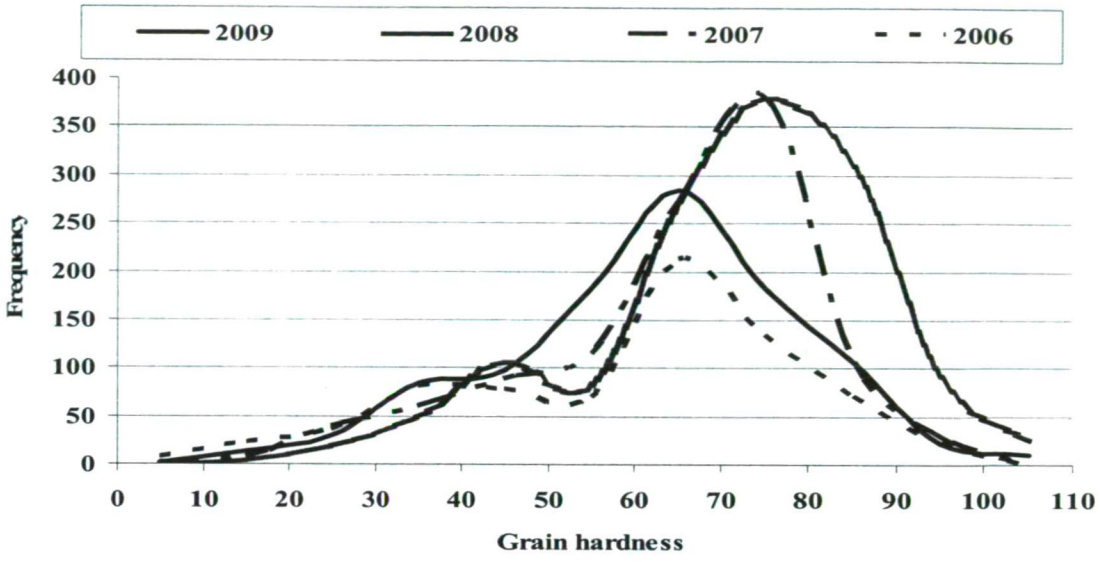
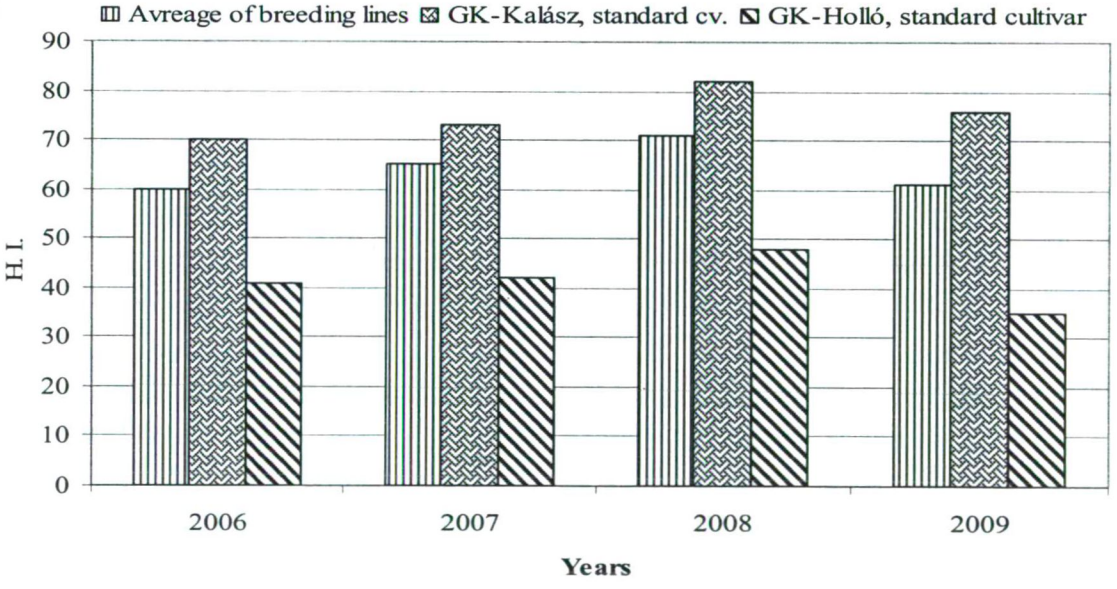


Figure 3. Grain hardness index (H.I.) at Szeged-Kecskés breeding station, Hungary, 2006-2009



The other advantageous effect is that we take in consideration the "Pannon" requirements when choosing the crossing partners for starting new combinations.

On the other hand in this work we cannot skip other important agronomic characteristics (winter hardiness, resistance, stem etc.). No doubt that in breeding for quality how important the breeding material is since successful selection can be done only

from a wide genetic variability. In our breeding program we created numerous new crossing combinations for widening the genetic background of our material.

CONCLUSIONS

Pannon quality criteria determine two high quality clusters which will fit many demands of users. But we also know that the demands of the market are always changing. Therefore in all the long term projects, (in breeding) we must create more quality types of genotypes. Breeders must make long term plans while paying attention to foreign and domestic demands. We cannot be unilateral since the claims are always change here and abroad as well.

There is only one thing that will not change: We will need bread, flour for our life in the future too. For this, we will need good wheat, which will be our daily bread through the work of skilful farmers, millers and bakers.

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WEATHER CHARACTERISTICS OF 2009 WITH ASPECT OF SPRING FIELD CROPS GROWING IN PANNONIAN REGION OF CROATIA

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ABSTRACT - Weather characteristics of 2009 with aspect of field crops growing in Pannonian region of Croatia

Aim of this study was appreciation of the 2009 growing season with aspect of spring crops growing in Pannonian region of Croatia and its comparison with favourable 2005 and unfavourable 2007. With that regard, precipitation and air-temperature regime impacts were focused. Total six weather bureaus were used as source of weather data as follows: Osijek, Gradište (near to Zupanja) and Slavonski Brod situating in Eastern Croatia; Bjelovar, Sisak and Zagreb-Maksimir situating in Central Croatia. Precipitation in the April-September period of 2009 was 306 mm (mean of six tested localities of the region) or 31 % lower in comparison with long-term mean (LTM) 1961-1990 (442 mm) but at same time air-temp. was for 2.4 °C higher (19.5 °C and 17.1 °C, respectively). However, weather characteristics in July and August have especially effects on spring crops growing. In general, water deficit in combination with higher air-temp. have detrimental effects. Precipitations in July+August of 2009 (means of three representing localities) were 81 mm (LTM = 140 mm) and 152 mm (LTM = 166 mm), for Eastern Croatia and Central Croatia, respectively. At the same time mean air-temp. were 23.0 °C (LTM = 20.5 °C) and 22.5 °C (LTM = 20.0 °C), respectively. These data are indicator of less favorable weather conditions in 2009 for spring crops growing. Comparison of weather characteristics in two recent growing seasons is a typical example degree of their favorability. Under favourable weather conditions of the 2005 growing season, precipitation in July + August (means of six tested localities of the region) were 328 mm or more than 2 fold more in comparison with LTM (154 mm). At the same time, air-temp. was 20.4 °C (LTM: 20.2 °C). However, analogical data for the unfavourable 2007 were 95 mm or 38 % lower than LTM and it is accompanied with the higher air temp. (22.7 °C) for even 2.5 °C. As result of these differences of weather characteristics are maize yields 4.87 t/ha in 2007 or about 30% lower than in 2005 (means of six counties covering tested weather bureaus centers).

Key words: air-temperatures, precipitation, spring crop yields, Croatia

SAŽETAK: Karakteristike vremenskih prilika 2009. g sa stajališta uzgoja proljetnih usjeva u Panonskoj regiji Hrvatske

Cilj ovoga rada je procjena vegetacije 2009. g s aspekta uzgoja proljetnih kultura u Panonskoj regiji Hrvatske i usporedba s povoljnom 2005. i nepovoljnom 2007. g. U tom pogledu je analiziran utjecaj oborinskog i temperaturnog režima. Ukupno šest meteoroloških postaja je korišteno kao meteoroloških podataka (oborine i srednje temperature zraka): Osijek, Gradište (kod Županje) i Slavonski Brod (subregija Istočna Hrvatska), Bjelovar, Sisak i Zagreb-Maksimir (subregija Središnja Hrvatska). U razdoblju travanj-rujan 2009. palo je prosječno 306 mm kiše (prosjek za šest lokaliteta) ili 31% manje od višegodišnjeg prosjeka (VGP) 1961-90 (442 mm), a istovremeno su temperature zraka bile za 2,4 °C više (19.5 °C, odnosno 17.1 °C). Međutim, vremenske prilike u dva ljetna mjeseca (srpanj i kolovoz) imaju osobito utjecaj na uzgoj proljetnih usjeva. Općenito, suša u kombinaciji s visokim temperaturama zraka imaju štetan utjecaj. U srpnju i kolovozu 2009. palo je 81 mm kiše u Istočnoj Hrvatskoj, odnosno 152 mm u Središnjoj Hrvatskoj (prosjeci po tri lokaliteta) , a temperature zraka iznosile su 23.0 °C (VGP = 20.5 °C), odnsono 22.5 °C (VGP = 20.0 °C). Ovi podaci ukazuju na manje povoljne uvjete za uzgoj proljetnih kultura u 2009. godini. Usporedba vremenskih prilika u dvije vegetacije mogu poslužiti kao tipični primjeri stupnja njihove pogodnosti. U povoljnim uvetima 2005. g oborine u srpnju i kolovozu iznosile su 328 mm (prosjek za šest lokalita regije) ili preko 2 puta iznad VPG a temperarture zraka bile su 20.4 °C u rangu VPG (20.2 °C). Međutim, analogna usporedba za nepovoljnu 2007. je 95 mm ili 38 % manje od VPG i 22,7 °C ili za 2,5 °C veća od VPG.

Kao rezultat ovih razlika vremenskih prilika su i prinosi kukuruza 4,87 t/ha ili oko 30% niži nego u 2005. godini (prosjeci za šest županija koje pokrivaju šest meteoroloških postaja).

Ključne riječi: temperature zraka, oborine, prinos proljetnih usjeva, Hrvatska

INTRODUCTION

Weather characteristics are important factor of field crops yield under agroecological conditions of Croatia. They are main reason for considerable varying of yields of individual crops among years for short period. For example, in decade- period 1998-2007 maize yield variation in Croatia (State Bureau for Statistics, 2008) was in range from 3.86 t/ha (2007) to 6.92 t/ha (2005) and they are mainly resulted by weather characteristics (KOVACEVIC ET AL., 2009; SOSTARIC AND JOSIPOVIC, 2006). Aim of this study was appreciation of the 2009 growing season with aspect of spring crops growing and its comparison with favourable 2005 and unfavourable 2007. With that regard, precipitation and air-temperature regime impacts were focused.

MATERIAL AND METHODS

Source of the data

For this study, the data from State Hydrometeorological Institute (precipitation and air-temperature) and State Institute for Statistics (statistical yearbooks: maize yield) were used. Total six weather bureaus were used as source of weather data as follows: Osijek, Gradište (near to Zupanja) and Slavonski Brod representing Eastern Croatia, Bjelovar, Sisak and Zagreb-Maksimir representing Central Croatia. Rain factor (RFm) was calculated monthly as quotient of precipitation (mm) and mean air-temperatures (°C) according GRACANIN (1950).

Description of the area

Pannonian region of Croatia is mainly lowland area of the country and occupies close to 60% of the state territory. It was divided in Central Croatia and Eastern Croatia regions and both are main field crops growing area. However, the eastern part of the region is more important with aspect of field crop growing because of more favourable agroecological, especially soil, conditions.

RESULTS AND DISCUSSION

Water storages in soil at beginning of the spring crops 2009 growing season were mainly in level of long-term means (LTM: 1961-1990) based on criterion precipitation quantities for three-month period (January-March: precipitation 150 mm and 154 mm, for 2009 and LTM, respectively). Precipitation in the April-September period of 2009 was 306 mm (mean of six tested localities of the region) or 31 % lower in comparison with LTM (442 mm) but at same time air-temperatures was for 2.4 °C higher (19.5 °C and 17.1 °C, respectively). However, weather characteristics in two summer months (July + August) have especially effects on spring crops growing. In general, water deficit in combination with higher air-temperatures have detrimental effects. Precipitations in July+August of 2009 (means of three representing localities) were 81 mm (LTM = 140 mm) and 152 mm (LTM = 166 mm), for Eastern Croatia and Central Croatia, respectively. At the same time mean air-temperatures were 23.0 °C (LTM = 20.5 °C) and 22.5 °C (LTM = 20.0 °C), respectively (Tables 1 and 2). These data are indicating less favorable weather conditions for spring crops growing.

Table 1. Precipitation and air-temperatures in Pannonian region of Croatia in 2009

Locality	Monthly precipitation (mm) and mean air-temperature (°C) for the 2009 growing season													
	April		May		June		July		August		September		Σ	X
	mm	°C	mm	°C	mm	°C	mm	°C	mm	°C	mm	°C	mm	°C
	EASTERN CROATIA SUBREGION (the eastern part of Pannonian region)													
Osijek	19	14.6	39	18.3	63	19.2	14	23.2	61	22.9	10	19.1	**206**	20.0
Zupanja	19	14.8	38	18.9	77	19.5	43	23.4	37	23.2	2	19.7	**244**	19.9
Slav. Brod	13	14.2	44	18.1	104	19.3	61	22.6	29	22.3	29	18.7	**280**	19.2
x	**17**	**14.5**	**40**	**18.4**	**81**	**19.3**	**39**	**23.1**	**42**	**22.8**	**14**	**19.2**	**233**	**19.6**
	Precipitation in the January-March period: 132 mm (mean of three localities)													
	CENTRAL CROATIA SUBREGION (the western part of Pannonian region)													
Bjelovar	33	14.9	50	18.1	102	19.2	50	22.4	21	22.6	37	18.5	**293**	19.3
Sisak	31	14.8	44	18.7	153	19.7	171	22.5	37	22.4	30	18.0	**466**	19.4
Zagreb	52	14.5	49	18.4	68	19.8	96	22.3	79	22.6	22	18.9	**366**	19.4
x	**39**	**14.7**	**48**	**18.4**	**108**	**19.6**	**106**	**22.4**	**46**	**22.5**	**30**	**18.5**	**374**	**19.4**
	Precipitation in the January-March period: 167 mm (mean of three localities)													
	MEANS OF BOTH SUBREGIONS													
	28	**14.6**	**44**	**18.4**	**95**	**19.5**	**73**	**22.8**	**44**	**22.7**	**22**	**18.9**	**306**	**19.5**

Table 2. Precipitation and air-temperatures in Pannonian region: long-term means (1961-1990)

Locality	Monthly precipitation (mm) and mean air-temperature (°C): means 1961-1990													
	April		May		June		July		August		September		Σ	X
	mm	°C	mm	°C	mm	°C	mm	°C	mm	°C	mm	°C	mm	°C
	EASTERN CROATIA SUBREGION													
Osijek	54	11.3	59	16.5	88	19.5	65	21.1	59	20.3	45	16.6	**370**	17.6
Zupanja	Data not-available (45 km air-distance from Osijek toward south)													
Slav. Brod	58	10.9	73	15.9	86	19.0	83	20.7	73	19.8	62	16.1	**435**	17.1
x	**56**	**11.1**	**66**	**16.2**	**87**	**19.3**	**74**	**20.9**	**66**	**20.1**	**54**	**16.4**	**403**	**17.3**
	Precipitation in the January-March period: 138 mm (mean of two localities)													
	CENTRAL CROATIA SUBREGION													
Bjelovar	63	10.8	79	15.6	96	18.7	78	20.4	82	19.5	65	15.8	***463***	16.8
Sisak	73	11.1	82	15.8	91	19.1	77	20.8	85	19.8	76	16.0	***484***	17.1
Zagreb	64	10.6	79	15.3	100	18.5	83	20.1	95	19.3	79	15.8	***500***	16.6
x	***67***	**10.8**	***80***	**15.6**	***96***	**18.8**	***79***	**20.4**	***87***	**19.5**	**73**	**15.9**	**482**	**16.8**
	Precipitation in the January-March period: 169 mm (mean of three localities)													
	MEANS OF BOTH SUBREGIONS													
	62	**11.0**	**73**	**15.9**	**92**	**19.1**	**77**	**20.7**	**77**	**19.8**	**64**	**16.2**	**442**	**17.1**

Comparison of weather characteristics in two recent growing seasons (2005 as favorable and 2007 as unfavorable) are typical example of weather impacts on spring crops yield in example of maize as the first-ranged field crop of the region: under less favorable weather conditions of 2007 maize yields were 4.87 t/ha or about 30% lower than under

favorable conditions of 2005 (Table 3). Under favourable weather conditions of the 2005 growing season, precipitation in two summer months (July + August: means of six tested localities of the region) were 328 mm or more than 2 fold more in comparison with LTM. At the same time, air-temperature was close to LTM. However, analogical data for the unfavourable the 2007 growing season were 95 mm or 38 % lower than LTM and it is accompanied with the higher air temperature for even 2.5 °C (Tables 1 and 2). In general, drought and hot stresses are more detrimental factor for the spring crops yield under conditions of Eastern Croatia subregion (KOVACEVIC ET AL., 2009) and the data for 2007 are in accordance with this observation.

Table 3. Precipitation and air-temperatures in Pannonian region for two growing seasons

Maize yield t/ha**	Precipitation (mm) and mean air-temperature (°C) *													
	April		May		June		July		August		September		Σ	X
	mm	°C	mm	°C	mm	°C	mm	°C	mm	°C	mm	°C	mm	°C
	THE FAVORABLE GROWING SEASON (2005)													
	a) Eastern Croatia (the eastern part of Pannonian region) sub-region													
7.51	62	11.7	46	17.0	94	19.5	160	21.6	209	19.4	71	17.1	**642**	**17.7**
	b) Central Croatia (the western part of Pannonian region) sub-region													
6.86	64	11.7	74	16.6	61	19.9	121	21.5	166	19.0	71	16.9	**557**	**17.6**
	Means in level of both sub-regions (a + b)													
7.19	**63**	**11.7**	**60**	**16.8**	**78**	**19.7**	**140**	**21.6**	**188**	**19.2**	**71**	**17.0**	**600**	**17.7**
	THE UNFAVORABLE GROWING SEASON (2007)													
	a) Eastern Croatia (the eastern part of Pannonian region) sub-region													
4.95	5	13.5	85	18.2	61	22.4	31	23.6	45	22.4	90	14.5	**317**	**19.1**
	b) Central Croatia (the western part of Pannonian region) sub-region													
4.79	5	13.8	72	18.2	67	22.4	42	23.2	72	21.5	144	14.6	**402**	**18.9**
	MEANS OF BOTH SUBREGIONS													
4.87	**5**	**13.7**	**78**	**18.2**	**64**	**22.4**	**36**	**23.4**	**59**	**21.9**	**117**	**14.6**	**359**	**19.0**

* means of three Weather Bureaues: a = Osijek + Zupanja + Slavonski Brod; b = Bjelovar + Sisak + Zagreb

** means of three Counties: a = Osijek-Barannya +Vukovar-Syrmium + Brod-Posavina; b = Bjelovar-Bilogora + Sisak-Moslavina + Zagreb

Table 4. Rain factor (RFm) values according GRACANIN (1950)

Pannonian subregion	Rain factor (RFm = precipitation / air-temperature) - GRACANIN (1950)								
	2005			2007			2009		
	June	July	Aug.	June	July	Aug.	June	July	Aug.
a) Eastern Croatia	4.8sa	7.4h	10.1h	2.7a	1.3pa	2.0a	4.2sa	1.7a	1.8a
b) Central Croatia	3.1a	5.6sh	8.7h	3.0a	1.8pa	3.3a	5.5sh	4.7sa	2.0a
Legend: a = arid, h = humid, sa = semiarid, sh = semihumid, pa = perarid, ph = perhumid									

According Gracanin' s Rain factor (RFm) weather in July and August of 2009 had characteristics of semiarid/arid climate in Eastern Croatia subregion and status in Central Croatia subregion was slightly more favourable (semihumid/semiarid/arid). Also, in the same time perarid /arid conditions were main characteristics of unfavourable the 2007 and semiarid/humid conditions characterized favourable the 2005 growing season (Table 4).

Similar effects of weather characteristics on maize yields were found by our earlier studies and they are in accordance by experiences from USA Corn Belt (THOMPSON, 1986; SHAW 1988). KOVACEVIC ET AL., (1994) showed yields of maize in Croatia for the 1960-1989 period. Precipitation in 4-month (May-August) period for tested period were 214 mm (Osijek) and 249 mm (Podr. Slatina). Grain yields variation among the year were from

3.14 t/ha to 8.43 t/ha (former municipality Vukovar – now part of Vukovar-Syrmium County: mean yield 6.00 t/ha) and from 2.94 t/ha to 5.81 t/ha (former municipality Podr. Slatina– now part of Virovitica-Podravina County: mean yield 4.13 t/ha). Degree of soil fertility between Vukovar and Slatina areas (JANEKOVIC, 1971) is main reason for maize yield differences.

In general, the lower yields of maize were in connection with the lower precipitation, especially in area of former Vukovar municipality. For example (KOVACEVIC ET AL., 1994), yield variation among years for the 1960-1989 period in Vukovar municipality was in the range from 3.14 t/ha (1961: precipitation in Vukovar during July+August 37 mm) to 8.43 t/ha (1984: precipitation 134 mm). At the same time, in Podr. Slatina municipality, maize yields for the focused years were 2.94 t/ha (1961: precipitation in Podr. Slatina during July+August 95 mm) and 5.22 t/ha (1984: precipitation 132 mm). JOSIPOVIC ET AL. (2005) reported variation of maize yields in Brod-Posavina County for the period 1981-2003. With that respect, precipitation in May-August period (Slavonski Brod Weather Bureau) had considerable influences on maize yields in formerly Slav. Brod municipality (1981-1990: range from 2.91 to 5.84 t/ha, precipitation 175 mm and 335 mm, respectively) and Brod-Posavina County (1996-2003: range from 3.98 to 6.42 t/ha, precipitation 219 mm and 334 mm, respectively).

JUG ET AL. (2007) tested impacts of soil tillage practices on maize yields under conditions of Baranya (stationary field trial on chernosem in the 19991-2001 period). Under normal weather conditions of the 1999 growing season (precipitation in July+August 125 mm) maize yielded 9.55 t/ha (no-tillage system) to 10.53 t/ha (conventional soil tillage). However, under drought stress of 2000 (only 48 mm) by no-tillage practice yield was drastically reduced (0.76 t/ha and 7.81 t/ha, respectively).

However, sunflower yielded considerably lower under wet year conditions. LIOVIC ET AL., (2006) reported data of sunflower yields and weather characteristics of individual growing season from 1981 to 2003 in Eastern Croatia. Under wet conditions of the 1982, 1999 and 2001 growing seasons (mean precipitation in Nasice for June-August = 349 mm) yield of sunflower were less than 2 t/ha (mean 1.76 t/ha), while under normal and dry conditions they were above 2.0 t/ha.

CONCLUSIONS

Based on precipitation and air-temperature regimes, the 2009 growing season is characterized as less favorable for majority spring crops growing. With that respect, water shortage in combination with high air-temperatures, especially in August, are main responsible factor. Under these conditions, only sunflower is more tolerant, while for maize and soybean are relative more susceptible crops.

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POTENTIAL FILTER MEDIA FOR NUTRIENT REMOVAL IN VERTICAL SUBSURFACE FLOW CONSTRUCTED WETLANDS

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ABSTRACT –Potential filter media for nutrient removal in vertical subsurface flow constructed wetlands Peat, coco products, light-weight expanded clay and lava rock are used as alternate filter media to treat domestic wastewater in on-site constructed wetlands. The aim of this study is to examine the nutrient removal by these media. Column studies and adsorption tests were used to establish the possible nitrogen and phosphorus removal caused by these filter media. None of the tested lignocellulosic filter media showed an efficient phosphorus removal in these experiments. Removal of total nitrogen was very limited for both peat and coco products. A good nitrification was evident in all the filter media. In non-buffered coco peat a small quantity of nitrate was adsorbed. Because calcium nitrate is used for buffering of coco products, this adsorption will only be present in non-buffered coco products. Of course the overall nitrate removal is negligible. The main mechanism for ammonium removal is nitrification. From a certain point nitrification slows down and consequently ammonium-N removal reduces proportionally. The light-weight expanded clay produced in Flanders (Argex), shows a good capacity for phosphorus sorption. Taking into account the typical dimensions and characteristics of a vertical subsurface flow constructed wetland ($3m^2$/P.E.; infiltration column 80cm) and the density of Argex, this means the constructed wetland will be saturated after approximately 20 months, assuming 1 P.E. stands for 2 mgP/d. Lava rock seems to be a very good substrate for nitrification. Phosphorus removal is limited but better than the filter media generally used in constructed wetlands.

Keywords Constructed wetlands; nutrients; peat; coco peat; coir pith , light-weight expanded clay, lava

INTRODUCTION

Discharge of wastewater is one of the major sources of nitrogen and phosphorus entering water bodies, causing undesired environmental problems such as eutrophication and algae bloom. Important sources of nutrient-pollution in Belgium and in other European countries are single households in rural areas discharging inadequately treated wastewater. These households have to rely upon on-site, low-cost small-scale wastewater treatment systems, for instance constructed wetlands (VYMAZAL J. ET AL. 1998). Constructed wetlands have proved to remove nutrients and different removal mechanisms taking place have been identified (KADLEC R. ET AL. 1996). In order to achieve efficient cost effective treatment systems, natural materials, e.g. sands, gravel, light-weight expanded clay, lava rocks, peat, coco products etc., are generally been applied as filter substrates in constructed wetlands.

In a vertical subsurface flow constructed wetland, a liquid phase and air are passed through the filter media, invoking the processes of adsorption and aerobic biological degradation of the nutrients in the liquid. The relative extent to which adsorption or biological degradation dominates in nutrient removal may vary with the filter substratum used, as well as with local conditions like pH and temperature. The interdependence of these processes is still unclear. Adsorption of solutes onto the surface of organic media may benefit or hinder their subsequent degradation by micro-organisms (MCNEVIN D. ET AL, 1998).

As a low cost, particulate medium, peat is an attractive and inexpensive option for the removal of colloidal and dissolved pollutants, although such advantages must be balanced against the importance of peatland conservation and the maintenance of habitat diversity. Peat can be described as partially fossilised plant matter which accumulates in wet areas where there is a lack of oxygen and the accumulation of the plant material is more rapid than its decomposition (COUILLARD D., 1994). Peat is a porous, complex material containing lignin, cellulose and humic acids as major constituents. These constituents contain polar functional groups, such as alcohols, aldehydes, ketones, carboxylic acids, phenolic hydroxyls, phenolic acids and ethers that can be involved in chemical bonding. Because of the polar character of peat, the specific adsorption potential for dissolved solids is quite high. Several studies have established the potential of peat to capture organic matter, nutrients, suspended solids, dissolved metals, oils and odors from domestic and industrial wastewater (BROWN P.A. ET AL., 2000). The particulate and highly porous nature of peat also makes it an effective physical filter. Studies have shown that partially decomposed peat has a relatively high porosity of approximately 95% and a specific surface area of 200 m^2 per g (HEADLEY T., 2006).

Coir is the name given to the fibre that constitutes the thick mesocarp or husk of the coconut (*Cocos nucifera*) fruit. This fibre is used for manufacturing ropes, matting and many other products. When the husk is processed, industrially valuable long fibres are removed leaving a considerable amount of both pith tissue and short- to medium-length fibres. These materials remain available as a waste product. Coir waste may be screened to remove part or most of the fibre. The light fluffy material, which is generated in this separation process is called coir pith or coco peat. This raw coir pith consists of 35% cellulose, 25.2 % lignin, 7.5% pentosans, 1.8% fat and resins, 8.7% ash content, 11.9% moisture content and 10.1% other substances. Coir pith was tested for the removal of many different contaminants: organic matter, nutrients, metals, dyes (NAMASIVAYAM C. ET AL., 2008).

Constructed wetlands that use lava rocks as filter material are widely used in Belgium for the treatment of water from swimming ponds and fish ponds. Lava biofilters are also used as a first stage in a multistage constructed wetland treating agricultural wastewater. In most cases the system works as a saturated filter reactor. These constructed wetlands are typically planted with *Iris pseudacorus*. They were never subject of accurate scientific research. Lava rocks are also an important filter material in trickling filters treating contaminated air.

Light-weight expanded clay aggregates (LWA) are presented by many authors as a possible medium for phosphorus (P) removal in constructed wetlands (DRIZO A. ET AL., 1999, BRIX H. ET AL, 2001, JOHANSSON L., 1998). Light-weight expanded clay aggregates are produced by the high temperature (up to ca. 1200°C) calcination of clay minerals. During the calcination in rotary kilns the organic matter in the clay expands, resulting in a high porosity mineral of low bulk density with higher hydraulic conductivities than similar sized sands and gravels. The results presented by the different authors suggest that the phosphate uptake capacity may vary over two orders of magnitude up to ca. 3.5 mg/g. The primary determinant of phosphate uptake is the total metal, and in particular Ca concentration (ZHU T. ET AL., 1997). Field evaluation demonstrated an efficient nitrification via adsorbed microbial biomass (HEISTAD A. ET AL., 2006).

The objective of this paper is to evaluate nutrient removal treating N- and P-solutions by percolation over different types of substrates. The filter media tested are all readily available in Flanders.

MATERIALS AND METHODS

Materials

Peat. The peat used was a mixture of 50% Irish peat and 50% Baltic peat. Irish peat is a more stable product, Von Post scale H3-H5. Baltic peat contains more fibres and is less decomposed, Von Post scale H1-H3. Two types were tested: an untreated mixture and a mixture treated with lime. Peat-based substrates are treated with lime to neutralize substrate acidity, increase pH buffering capacity, and provide calcium and magnesium.
Coco products. Three types of coco products were tested: coco chips, non-buffered coco peat, and buffered coco peat. Coco chips are produced by cutting the husk of the coconut into pieces. This results in a fibrous material with fibre sizes between 5 and 11 mm. The fibres are not washed. This product is used as a filter substrate in small on-site wastewater treatment systems in Belgium. Coco peat (or coir pith) is used as a growing medium for container-grown ornamental plants. Coco peat is always washed with water. 90% of the particles have a size smaller than 3 mm. Because coco peat has a negatively charged complex it is surrounded by positively charged ions primarily consisting of sodium and potassium. A buffering process can be applied to exchange sodium and potassium with calcium. During this process coco peat is treated with a solution of $Ca(NO_3)_2$.

Argex is a light-weight expanded clay aggregate produced in Flanders. The raw material used for this type of LWA is the Rupelian Boom clay. This type of clay has very distinct qualities (DECLEER J. ET AL., 1993). It is a suitable raw material since it contains components which liberate gases at a specific temperature and it has a chemical composition which produces a high temperature melt with a viscosity high enough to trap these gases. Although the composition of Rupelian Boom clay is far from ideal. Some parts of the clay deposit contain more organic matter than others. The presence of more than 3% organic matter has a negative influence on the expansion. In addition it is not clear why more iron has to be added to the Rupelian Boom clay in comparison with other European clays with a similar chemical composition. Industrial experience has shown that the addition of iron compounds facilitates the expansion process. During production a metallurgical waste product, containing ferric oxides is added. Ferric oxides are known to be capable of binding phosphorus strongly. However, since carbon is present in the raw material as organic matter, it is able to reduce the iron oxides. The expanded clay tested was the Flemish Argex 0-4. Grains of Argex are rough in appearance and rounded in shape. The surface of the grains is made up of a brown microporous crust. The interior of the grains has a black cellular texture. The grains were sized between 0 and 4 mm. The substrate contains 90 mg/g Al, 100 mg/g Fe, 14 mg/g Ca, 9 mg/g Mg.

The *lava stones* used in the test, originate from the volcanic Eifel region in Germany. It is a commercial product used as a filter material in pond filters and in drain layers on green roofs (Lavadrän 2/12 and 8/16, Vulkatec). This porous volcanic rock consists mainly of augite, olivine, limonite and biotite. Two different granulometries were tested, between 2 and 12 mm, between 8 and 16 mm. The substrate contains 53 mg/g Al, 84 mg/g Fe, 93 mg/g Ca, 84 mg/g Mg.

Batch studies

The maximum phosphate adsorption capacity was determined using a batch equilibrium technique as described by Seo (SEO ET AL. 2005).

Column studies

A pilot plant with infiltration columns was constructed. These columns were set up and operated as a vertical subsurface flow wetland (without macrophytes). The columns were applied with a solution containing NH_4NO_3 (45ppm N) and KH_2PO_4 (15 ppm P). The hydraulic loading was 50 $l/m^2.d$, the water was applied once a day. A daily sample was taken from the effluent of the columns, proportional to the quantity. These samples were tested for NH_4^+-N, NO_3^--N, total P, pH and conductivity.

Another pilot plant was built to determine the maximum adsorptive capacity of certain filter substrates for N or P. This pilot plant operates in exactly the same way, but other salt solutions were used (75 mgP/l, 150 mgP/l, 225 mgN/l, 450 mgN/l). In an identical set-up, the nitrification in lava stone was examined. Three columns were prepared. One column was filled with untreated lava 2/12. In another column lava 2/12 was used, cooked in water during 15 minutes prior to the test. Both columns were applied with a solution containing 22.5 mg NH_4^+-N/l and 22.5 mg NO_3^--N/l. To the influent of a third column packed with lava 2/12, a nitrification inhibitor was added, 15 mg/l allylthiourea.

Analytical methods

Total phosphorus was determined photometrically according to the phosphormolybdenum blue method (Spectroquant Phosphate Cell Test 14729). NH_4^+-N and NO_3^--N were analysed with ion specific electrodes (Symphony Electrodes). A calibration of the ion specific electrodes was performed before and after the analysis of the samples. pH was measured with a Symphony pH electrode, epoxy, gel, 3 in 1. Electrical conductivity was determined with a Hanna Instruments conductivity meter HI99300.

RESULTS AND DISCUSSION

Phosphorus

On average the removal percentages for total phosphorus were 5.6 % for coco chips, 12.0 % for buffered coco peat, 8.8 % for coco peat, 15.7 % for limed peat and 8.6 % for peat. From these results can be concluded that the adsorptive capacity for phosphorus of these lignocellulosic products is very low. There was no significant difference between the filter media ($\alpha = 0.05$). The higher calcium content of limed peat and buffered coco peat only results in a small increase of the adsorptive capacity. In the beginning of the column test with coco chips an important release of phosphorus was observed, which decreased during the first 3 weeks. This coincided with a decrease of the electrical conductivity and an increase of pH. The electrical conductivity changed from 3.66 mS/cm to 0.36 mS/cm, the pH from 6.59 to 7.58. Since this type of coco chips is not washed before use, solutes are washed out in the beginning of the treatment process.

After a test period of 20 weeks, the expanded clay showed an average reduction percentage of 76,2%, calculated from the mass balance. Two types of lava rock with different size distribution were tested, i.e. 2-12mm and 8-16mm. The first removed 48,3%, the latter 41,6%.

The adsorption experiments showed that P-adsorption in LWA followed the Langmuir isotherm. Using the Langmuir equation, the theoretical P adsorption capacity was calculated for two products: round Argex AR0/4 0.81 mgP/g and crushed Argex AG0/4 1.33 mgP/g. The crushed LWA showed a higher adsorption capacity since this product has a greater surface area. D10 of the crushed product is 0.063 mm, D60 1.00 mm, for the round LWA these values are 0.125 and 2.00 respectively. Because of the specific characteristics of Rupelian Boom clay, more iron has to be added to the clay to enhance the

expansion process. This added Fe_2O_3 is an important factor in the P-sorption by Argex. Adsorption tests were performed on a product produced in a laboratory pilot plant under the same processing conditions but without adding Fe_2O_3. The LWA without addition of Fe_2O_3 could adsorb only 0,43 mgP/g. If the granules were glowed at 900°C, the maximum adsorption decreases to 0.20 mgP/g. This glowing process causes the formation of a rim of crystalline hematite surrounding the granule, hindering the adsorption of P inside the granule. Because the conditions during an adsorption test differ clearly from the conditions during an infiltration study, the maximum P adsorption was also determined using the infiltration columns. Calculated from these results, the maximum P-adsorption was found to be 0,650 mgP/g for Argex AR 0/4.

Nitrogen

With the exception of untreated peat, all the lignocellulosic filter media demonstrated a good removal of ammonium nitrogen (Table 1). There was no significant difference between the buffered and the non-buffered coco peat ($\alpha = 0.05$).

Table 1. Mean removal percentages.

	coco chips	coco peat buffered	coco peat	limed peat	peat	
Total Phosphorus	5,6	12	8,8	15,7	8,6	%
Total Nitrogen	6,5	10,2	23,9	0	0	%
Ammonium N	63,5	83,4	86	75,1	26,4	%

From the cumulated mass balances can be concluded that the removal of ammonium nitrogen was stable during the 30 weeks test period, except for coco chips (Figure 1).

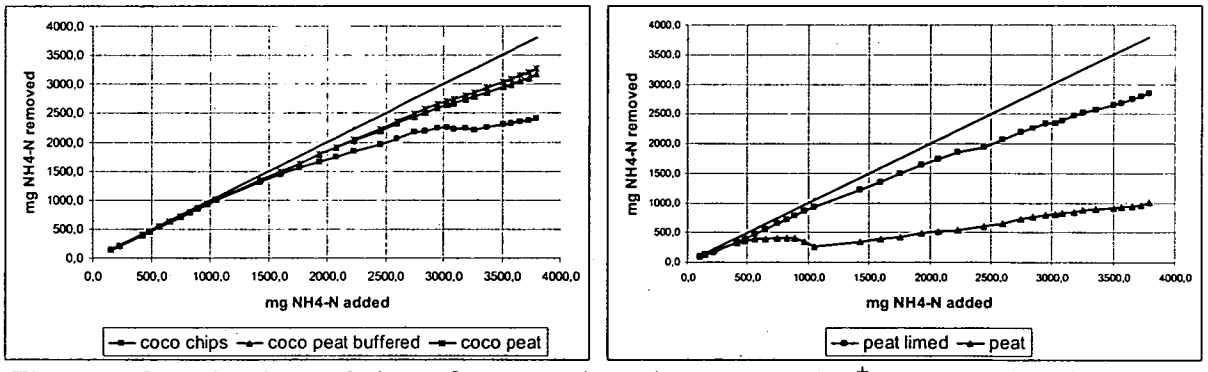

Figure 1. Cumulated mass balance for ammonium nitrogen, mg NH_4^+-N removed against mg NH_4^+-N added per column.

From the results of the nitrate analyses it was obvious that nitrification occurred in all the filter media, although the nitrification rate differed for the tested media. In the limed peat nitrification started after approximately one month. The untreated peat showed very slow nitrification due to the low pH of the medium (limed peat pH = 6.95, peat pH = 3.75). In the coco products nitrification started later compared to the peat products, after approximately 45 days. During this initial period the non-buffered coco peat was even able to adsorb nitrate (Figure 2).

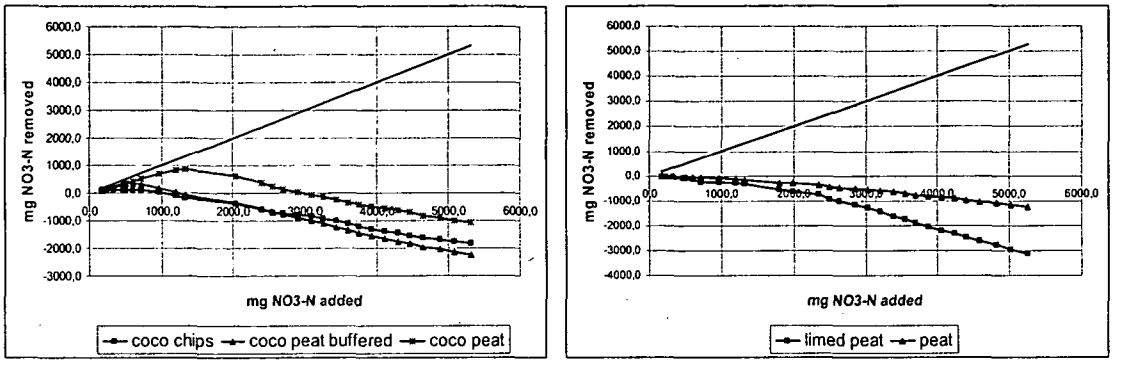

Figure 2. Cumulated mass balance for nitrate nitrogen, mg NO_3^--N removed against mg NO_3^--N added per column.

On average the removal percentages for total nitrogen were 6.5 % for coco chips, 10.2 % for buffered coco peat, 23.9 % for coco peat, 0.0 % for limed peat and 0.0 % for peat, as can be concluded from figure 3.

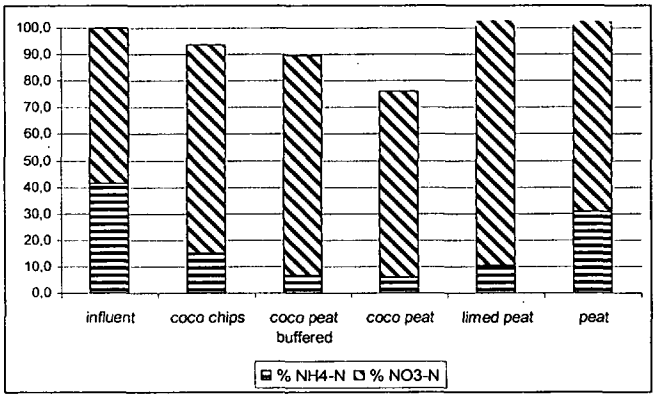

Figure 3. Ratio between ammonium-N and nitrate-N in terms of percentages.

Since both peat and coco products can be considered as negative complexes, positive ammonium ions can be adsorbed. Because non-buffered coco peat demonstrated the best ammonium removal, the nitrification and adsorptive capacity for ammonium was tested with NH_4NO_3-solutions of higher concentrations (TN: 225 mg N/l and 450 mg N/l). The results showed three different phases during nitrogen removal with non-buffered coco peat. In the first month nitrate-N is adsorbed (Figure 2) and ammonium-N was removed (> 96%). From the other results can be concluded that the nitrification process only starts after 30 to 45 days. This means the ammonium-N removal in this first phase can be attributed to adsorption. In a longer second phase ammonium-N was converted to nitrate-N, (ammonium removal = 50%). The third phase starts when approximately 2000 mg NH_4^+-N/kg substrate was removed. Both ammonium-N removal and nitrification approached almost zero (Figure 4). An important change in pH causes these phenomena. The pH decreases from 6.5 to 4.7. The low pH-conditions inhibit the growth of nitrifiers.

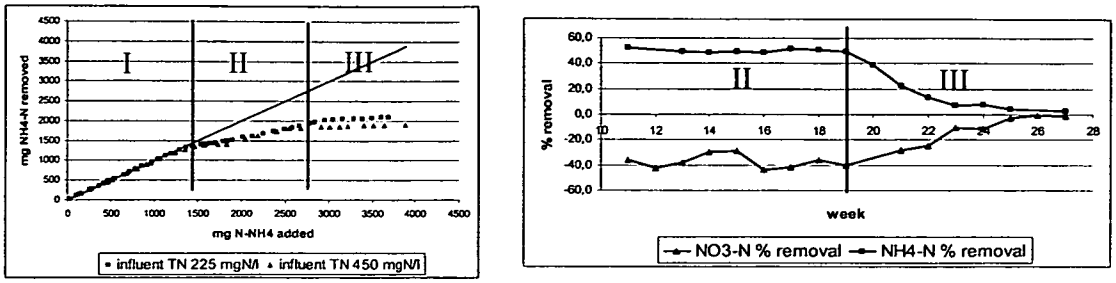

Figure 4. Left: Cumulated mass balance for ammonium nitrogen, mg NH_4^+-N removed against mg NH_4^+-N added per kg non-buffered coco peat; Right: Removal percentages for NH_4^+-N and NO_3^--N during the last 16 weeks for non-buffered coco peat (influent TN 225 mgN/l).

A mass balance showed a reduction percentage for total nitrogen of 29,8% with expanded clay. NH_4^+-N was decreased with 41,5% and NO_3^--N with 19,1%. After approximately 8 weeks of operation, nitrification became evident. Adsorption experiments proved that expanded clay cannot adsorb positive ammonium ions. The negative charged nitrate ion was adsorbed in small quantities: 0,11 mgN/g. The same amount was adsorbed in the presence of phosphate ions.

Lava rock seems to be a very good substrate for nitrification. Almost from the start of the experiments, ammonia was converted to nitrate. From the mass balances for NH_4^+-N and NO_3^--N could be calculated that 93,1% of the NH_4^+-N was nitrified, 5,9% was in solution in the effluent and 1% was present in the capillary water. The average reduction for total nitrogen was 12,5%. During this test period, one column was applied with the same influent but a nitrification inhibitor was added (Allylthiourea). The average reduction for total nitrogen was 40,8%: 29,4% was adsorbed as NH_4^+-N and 11,4% was dissolved as NH_4^+-N and NO_3^--N in capillary water.

CONCLUSIONS

None of the tested lignocellulosic filter media showed an efficient phosphorus removal in these experiments. Removal of total nitrogen was very limited for both peat and coco products. A good nitrification was evident in all the filter media. In non-buffered coco peat a small quantity of nitrate was adsorbed. Because calcium nitrate is used for buffering of coco products, this adsorption will only be present in non-buffered coco products. Of course the overall nitrate removal is negligible. The main mechanism for ammonium removal is nitrification. From a certain point nitrification slows down and consequently ammonium-N removal reduces proportionally.

The light-weight expanded clay produced in Flanders (Argex), shows a good capacity for phosphorus sorption. Taking into account the typical dimensions and characteristics of a vertical subsurface flow constructed wetland (3m²/P.E.; infiltration column 80cm) and the density of Argex, this means the constructed wetland will be saturated after approximately 20 months, assuming 1 P.E. stands for 2 mgP/d. Lava rock seems to be a very good substrate for nitrification. Phosphorus removal is limited but the better than the filter media generally used in constructed wetlands.

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NÉHÁNY ADAT AZ EGYES RÉGIÓK TERÜLETÉN LÉVŐ NEMZETI PARKOK IGAZGATÓSÁGAINAK ÁLLATTENYÉSZTÉSI LEHETŐSÉGEIHEZ

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ABSTRACT – Some date for animal breeding opportunities of managements of national parks on several region area
Nowadays the claims of animal breeders are increasing to the green agriculture and ecological animal keeping. The national parks have special ecological, tourism attraction for the rural development and the parks shows special modell picture for animal keeping. Generally native animal varieties are kept in a national parks. I examinated the big animal unit/hectar in areas for managements of national parks.

Keywords: managements of national parks, ecological animal keeping, capacity of animal breeding, ecological tourism, big animal unit/hectar

BEVEZETÉS

Hazánkban az utóbbi néhány évben megnőtt az igény a növénytermesztés és a környezetvédelem egységének (PONGRÁCZNÉ ÉS MEZEI, 2008; PONGRÁCZNÉ, 2008; PONGRÁCZNÉ ET AL., 2009), valamint a fenntartható mezőgazdaság, a vidékfejlesztés, az ökológiai állattartás megvalósítása iránt. Az ökológiai állattartás általában az őshonos állatfajták tartását jelenti, melyek kialakulásában FUTÓ ET AL. (2009) szerint a környezeti, szociális és kulturális tényezők is szerepet játszanak. A Magyarországon működő Nemzeti Parkok Igazgatóságai (továbbiakban NPI) sajátos állattenyésztésükkel (gazdálkodásukkal) ökológiai modell képet mutathatnak a mezőgazdaság többi szereplőjének. A nemzeti parkok többnyire olyan állatállománnyal rendelkeznek, melyek nem tartoznak közvetlenül a hagyományos mezőgazdasági haszonállatok körébe. Saját állatállományt ma kifejezetten turisztikai, kutatási, természetvédelmi célból tartanak. A célok között szerepel(het) a gazdasági hasznosítás is (termék és alapanyag előállítás). Modellként szolgálnak a legeltetéses tartáshoz.

Az értékfenntartó gazdálkodásnak egyik legfontosabb alapköve a tájhoz, a környezetéhez illeszkedő feladatok megtalálása, vagyis olyan földhasználati rendszer kialakítása, amely magából a környezetből, annak adottságaiból és korlátaiból fakad, ahhoz a lehető legjobban illeszkedik (ÁNGYÁN ET AL., 2002). Az ökoturizmus a nemzeti parkok hasznosításának új lehetőségeit teszi lehetővé (ARADI, 1992). Az ökoturizmus fejlesztése, a világörökségi terület bemutatása szorosan összefügg a természeti értékek megőrzésével, a hagyományos földhasználati formák fenntartásával valamint az állatfajok extenzív tartásával (VERESS ET AL., 2000; VERESS, 1987).

A szarvasmarha-tenyésztés szakosodásával kettévált a tej- és húshasznú tehéntartás, jelentősen megváltozott a tömegtakarmányok szerepe és ezzel a legeltetéses állattartás helyzete, jelentősége is. Egyre több gazdálkodó ismerte fel a legeltetés fontosságát a juh- és kecsketartók, de a szarvasmarha-tartók körében is (VINCZE, 2008). A juh-, kecske- és húsmarhatartásban nem volt vitatott, hogy azokat legeltetésre kell és lehet alapozni. A tehéntej-termelés esetében évtizedeken keresztül kizárólagos szerepe volt az intenzív tartási- és takarmányozási technológiának. Napjainkban azonban a kis- és közép méretű gazdaságokban ismét növekszik a legeltetési kedv tejelőtehén-tartásban is, magyartarka, holstein-fríz valamint keresztezett állományok esetében egyaránt. A magyar szürkét,

húsmarha fajtákat, bivalyokat és juhokat tartó nemzeti parkok élen járnak a legeltetéses állattartásban, példát mutatva a gazdálkodóknak (TASI, 2008).

A legeltetés a kérődző állatok élettanilag legkedvezőbb és leggazdaságosabb takarmányozási módja (BODÓ ET AL, 1986). Kardinális előnynek számít, hogy a megfelelő minőségű legelő egységnyi mennyiségű takarmányában több tápláló- és hatóanyaghoz jut az állat, mintha széna- vagy zöldtakarmány formájában kapná. A legelő füvében sok az ízanyag, ezért a jószág jó étvággyal eszi, rosttartalma a szénáénál kedvezőbb, ezért könnyebben emészthető telített zsírsav, aminosav- és nyomelem összetétele pedig változatosabb, mint a szántóföldi növényeké. A legeltetés során a környezeti hatások (friss levegő, napfény, mozgás) jótékonyan befolyásolják az állati szervezetet, edzettebb lesznek az egyedek (BÖÖ, 2010).

ANYAG ÉS MÓDSZER

Vizsgálataimat a magyarországi Nemzeti Parkok Igazgatóságainak adatai alapján végeztem (Kerekerdő, 2009). A célom az, hogy rámutassak arra: a környezeti adottságok azokon a területeken, amelyeket „központi modellnek" tekinthetünk nincsenek kellően kihasználva. Ezt a kihasználatlanságot másrészt az „állattenyésztési kapacitás" fogalmával kívánom bemutatni.

EREDMÉNYEK ÉS KÖVETKEZTETÉSEK

„Állattenyésztési kapacitás alatt egy adott gazdaság – földrajzi terület állateltartó képességét értem. Az állattenyésztési kapacitás (ÁK) mértéke: **nagyállat egység** (NÁ)/ **terület** (ha). A hozam mérőszáma a **húsegyenérték** (HE), ami kilogrammban adja meg az előállított alapanyagok mennyiségét a vizsgált területen tenyésztett – tartott állatok fajától függetlenül, azaz: a tej és tojástermelést is a (HE) fogalom fejezi ki. A HE-ben kifejezett hozam a pénzügyi (jövedelem, költség, stb.) számításokban is felhasználható.

Mindezt alapnak tekintve az állattenyésztési kapacitás általam kifejlesztett fogalmi variációjához tehát a Nemzeti Parkok Igazgatósága adatait használtam fel. Az állattenyésztési kapacitás számításának eredményeit a következő *1-3. táblázatok* tükrözik.

Az *1. táblázat* szerint a 1. **Kihasználási % (C oszlop)**: A szántóterületek állattartásra alkalmas minimuma (%-ban), azzal a szubjektív megítéléssel, hogy az egyes NPI-k területén kisebb egységek vagy egyáltalán nem, vagy csak a sajátosságok figyelembevételével szolgál(hat)nak takarmánytermelésre.

2. **Állateltartó képesség (E oszlop)**: mértéke az általam önkényesen használt Nagyállat Egység (NÁ), mely 500 kg élősúlyt jelent. Értékét 1,4 és 1,0 NÁ/ha között határoztam meg.. Az egyes NPI-oknál természetesen a helyre adaptált természetföldrajzi adottságait is figyelembe vettem.

3. **Az Eltartható maximális állatlétszám mértékét (F oszlop) az állatfajonkénti (H-L oszlop)** egyedszámot a 2. pontban leírtak alapján számítottam.

Szarvasmarha (H oszlop): minden egyedet (kortól, ivartól függetlenül) egy NÁ egységnek tekintek (a meglévő bivaly állományok adatait is ehhez az oszlophoz számítottam).

Sertés (I oszlop): mangalica fajtával, és a környezetvédelmi szempontok legszigorúbb figyelembevételével tartom lehetségesnek a sertéstartást.

Juh (J oszlop): hortobágyi racka, gyimesi racka, cikta, cigája fajtákat vizsgáltam meg.

Baromfi (K oszlop): húshasznosítás szempontjából meghatározó állatfaj is lehet egy-egy az adott térség egyes területein (integrációs lehetőség).

1. táblázat: Néhány Nemzeti Parki Igazgatóság (NPI) állattartásra alkalmas szántóterületének adatai (2009)

Nemzeti Parkok Igazgatóságai A)	Szántó terület (ha) (B)	Kihasználási (%) (C)	Használható terület (ha) (D)	Állateltartó képesség (NÁ/ha)*(E)	Eltartható max. állatlétszám (n) (F) Állatfaj (G)				Összesen (NÁ) (L)
					Szarvas-marha (H)	Sertés (I)	Juh (J)	Baromfi (K)	
1	1.050	60	630	1,4	882	3.528	7.056	202.860	882
2	16.923	50	8.461	1,4	11.846	23.692	47.384	2.724.580	11.846
3	8.126	60	4.876	1,1	6.826	27.304	54.608	1.569.980	6.826
4	17.097	50	8.548	1,0	8.548	34.194	68.388	1.966.040	8.548
5	18.118	50	9.059	1,0	9.059	36.236	72.472	2.083.570	9.059
6	12.647	50	6.323	1,0	6.323	25.294	50.588	1.454.290	6.323

Nemzeti parkok jelmagyarázat: 1. Aggteleki, 2. Bükki, 3. Duna-Ipoly, 4. Hortobágyi, 5. Kiskunsági, 6. Körös-Maros
Forrás: Kerekerdő (2009)

A gyepterületek hasznosítása alapvetően környezetvédelmi kérdés, annak feltételei határozzák meg az egyes fajok legeltetését, de a rét- és legelő gazdálkodást is. A *2. táblázatban* jól látható, hogy a **kihasználási % (C oszlop)**: mértékét szándékosan alulbecsülten (65 és 40 %) között adom meg, tekintettel az adott NPI gazdaságföldrajzi és egyéb (csapadék) adottságaira.

Az állateltartó képesség (E oszlop): mértékét (0,65-0,2 NÁ/ha) alacsony szinten veszem alapul, főleg a Hortobágyi és a Kiskunsági NPI-nél: 0,2 NÁ/ha.

Az összesen (L oszlop), illetve **állatfajonként (H-K oszlopok)** egyedszámainál (n) tudatosan nem veszem figyelembe azt a tényt, hogy nincsenek mindenhol nagy, összefüggő legelőterületek. Véleményem szerint ezt a hátrányt kisebb nyáj-egységekkel, illetve integrációval meg lehet oldani.

2. táblázat: Néhány Nemzeti Parki Igazgatóság (NPI) állattartásra alkalmas gyepterületének adatai (2009)

Nemzeti Parkok Igazgatóságai (A)	Szántó terület (ha) (B)	Kihasználási (%) (C)	Használható terület (ha) (D)	Állateltartó képesség (NÁ/ha)*(E)	Eltartható max. állatlétszám (n) (F) Állatfaj (G)				Összesen (NÁ) (L)
					Szarvas-marha (H)	Sertés (I)	Juh (J)	Baromfi (K)	
1	2.740	60	1.644	0,6	986	1.972	3.944	226.780	986
2	34.130	50	17.065	0,4	6.826	13.652	27.304	1.569.980	6.826
3	16.476	60	9.886	0,6	5.931	23.725	47.450	1.364.130	5.931
4	74.155	40	29.662	0,2	5.932	23.729	47.459	1.364.360	5.932
5	33.756	50	16.878	0,2	3.376	13.502	27.004	776.480	3.376
6	25.388	45	11.424	0,25	2.856	11.424	22.849	656.880	2.856

Nemzeti parkok jelmagyarázat: 1. Aggteleki, 2. Bükki, 3. Duna-Ipoly, 4. Hortobágyi, 5. Kiskunsági, 6. Körös-Maros
Forrás: www.kerekerdo.org (2009)

A *3. táblázat* adatai fajonként adják meg azt az állatlétszámot, ami a minimális feltételekkel az adott NPI-k területén tartható. **A realizálás mértéke, % (a. oszlop** – rész

fajonként): olyan arányt veszek figyelembe, ami a **területi kihasználási % (c oszlop**, 1-2. táblázat) mértékét tovább csökkenti, így tehát „túlbecsült érték". Így a javasolt létszámot mindenképpen megvalósíthatónak tartom, de azt emelni (is) lehet.

A faji megoszlás, % a b. oszloprész. Figyelembe vettem a már említett tényezőket (gazdaság földrajzi fekvését, éghajlatát, klímáját, de a régió sajátosságait is. (A kérődzőknél (szarvasmarha, juh) nem számolok külön a bivaly szerepével, bár azt is fontosnak tartom.)

Az eddigi feldolgozott terült (Dunántúltól a keletre eső régiók) adatai tanulságosak. További vizsgálatokat folytatok a dunántúli NPI-k állattenyésztési lehetőségeinek felméréséhez, a hozamok megbecsléséhez (húsegyenérték).

3. táblázat: Néhány Nemzeti Parki Igazgatóság (NPI) állattartó képességének létszámadatai (2009)

Nemzeti Park Igazgatóságok (A)	A realizálás mértéke (%) (a), a javasolt faji megoszlás aránya (%) (b), alapján a minimálisan tartható egyedek száma fajonként (n) (c) (B)											
	Szarvasmarha (C)			Sertés (D)			Juh (E)			Baromfi (F)		
	a	b	c	a	b	c	a	b	c	a	b	c
1	60	40	448	60	20	448	60	35	3.850	60	5	21.482
2	40	30	2.240	40	20	5.974	40	35	20.910	40	15	257.673
3	60	40	3.062	60	20	6.123	60	35	21.432	60	5	616.163
4	50	50	3.620	50	10	2.896	50	35	20.273	50	5	83.260
5	50	50	3.108	50	15	3.730	50	30	14.922	50	5	71.501
6	60	40	2.203	60	20	4.406	60	30	13.218	60	10	126.670

Nemzeti parkok jelmagyarázat: 1. Aggteleki, 2. Bükki, 3. Duna-Ipoly, 4. Hortobágyi, 5. Kiskunsági, 6. Körös-Maros

Forrás: saját adatok

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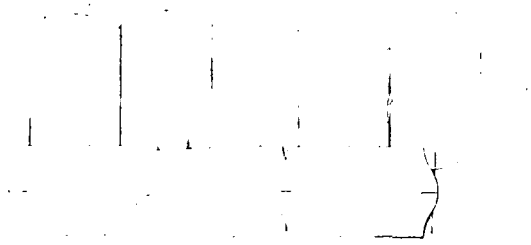

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